

Mark Scheme for June 2012

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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.

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Section A

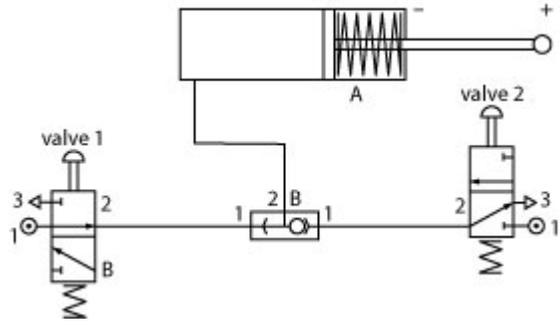
Question		Answer	Marks	Guidance
1		Input devices: Switch, potentiometer, thermistor, microphone or light dependent resistor (1). Output devices: Bell, buzzer, signal lamp, light emitting diode, loudspeaker or 7 segment display (1)	2	Award one mark for each correct device
2		Open loop system does not have feedback (1) Closed system has a feedback element (1)	2	
3		Overall gain $G = A / (1 - \beta A)$	1	
4		A device that merges several low-speed signals into one high-speed transmission and vice-versa	2	
5		An instrument display is a device or an output unit (1) gives a visual representation of data (1)	2	
6		Temperature control Rotational speed of a dc motor Power conditioning of a power supply Head positioning of a disk drive Seismometer Flight control system Heat exchangers	2	Accept any two correct responses
7		Reduction in costs Flexibility Efficiency Accessibility Speed	2	Accept any two correct responses

Question	Answer	Marks	Guidance										
8	A waveguide is a special form of transmission line (1) consisting of a hollow, metal tube. The tube wall provides distributed inductance, while the empty space between the tube walls provide distributed capacitance (1)	2											
9	Venturi meter Orifice plate Rotameter Turbine meter	1	Accept any correct response										
10	Bimetallic strip Capacitor Glass thermometer Potentiometer Thermistor Thermocouple <table border="1" data-bbox="353 751 1111 1337"> <thead> <tr> <th data-bbox="353 751 734 820">Situation</th> <th data-bbox="734 751 1111 820">Device</th> </tr> </thead> <tbody> <tr> <td data-bbox="353 820 734 959">This device consists of two different pieces of metal of the same length bonded together</td> <td data-bbox="734 820 1111 959">Bimetallic strip (1)</td> </tr> <tr> <td data-bbox="353 959 734 1098">When two different metals are joined together, a potential difference occurs across the junction</td> <td data-bbox="734 959 1111 1098">Thermocouple (1)</td> </tr> <tr> <td data-bbox="353 1098 734 1236">Semiconductor temperature device made from a mixture of metal oxides</td> <td data-bbox="734 1098 1111 1236">Thermistor (1)</td> </tr> <tr> <td data-bbox="353 1236 734 1337">A device that consists of two metal plates separated by an insulating material</td> <td data-bbox="734 1236 1111 1337">Capacitor (1)</td> </tr> </tbody> </table>	Situation	Device	This device consists of two different pieces of metal of the same length bonded together	Bimetallic strip (1)	When two different metals are joined together, a potential difference occurs across the junction	Thermocouple (1)	Semiconductor temperature device made from a mixture of metal oxides	Thermistor (1)	A device that consists of two metal plates separated by an insulating material	Capacitor (1)	4	
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	Section Total	20											

Section B

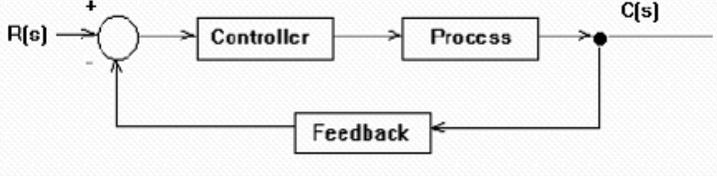
Question	Answer	Marks	Guidance
1	(a) Electronics test equipment Use in radios, televisions and telephones Bar graph module Indicator lamps Digital clocks Car lights Traffic lights	2	Accept any two correct responses
	(b) Small sizes available Long life Fast response Use less current Reliability Range of colours/Different shapes	2	Accept any two correct responses
	<div data-bbox="616 805 840 1149" data-label="Diagram"> </div> <p data-bbox="347 1157 1108 1292">A seven-segment display displays decimal numerals. The display is composed of seven elements. Individually on or off, they can be combined to produce simplified representations of the arabic numerals. (1)</p>	6	Award one mark for shape (1) Award one mark for correct sequencing of letters (1)

Question	Answer	Marks	Guidance
	<p>Often the seven segments are arranged in an oblique (slanted) arrangement, which makes reading easier. Each of the numbers 0, 6, 7 and 9 may be represented by two or more different glyphs on seven-segment displays. (1)</p> <p>The seven segments are arranged as a rectangle of two vertical segments on each side with one horizontal segment on the top, middle, and bottom. Additionally, the seventh segment bisects the rectangle horizontally. The segments are lettered A to G, as shown, where the optional decimal point, an eighth segment, is used for the display of non-integer numbers (1)</p> <p>In a simple LED package, each LED is typically connected with one terminal to its own pin on the outside of the package and the other LED terminal connected in common with all other LEDs in the device and brought out to a shared pin. This shared pin will then make up all of the cathodes (negative terminals) OR all of the anodes (positive terminals) of the LEDs in the device; and so will be either a "Common Cathode" or "Common Anode" device depending how it is constructed. A 7 segment display plus its decimal point will then only require nine pins to be present and connected. (1)</p>		
2	(a) <ul style="list-style-type: none"> Hoist in a degreasing plant Container filling machine Operating a micro-switch Clamping work to a machine table Opening a valve Transferring boxes from one conveyor belt to another Opening and closing doors In general anything that has to be pulled, pushed, lifted closed, opened, removed, held fast, operated, fed or squeezed Where the use of electricity would be dangerous 	2	Accept any two correct applications.

Question	Answer	Marks	Guidance
(b)	 <p>Fig. 1 shows a pneumatic circuit.</p> <p>A - single-acting cylinder (1) B – Shuttle valve (1)</p>	2	
(c)	<p>The single-acting cylinder is being controlled by two 3-port valves. (1) The shuttle valve routes air from valve 1 to the SA cylinder (1) and closes off the route to the exhaust port of valve 2. (1) Inside the shuttle valve is a small disc. (1) When an air signal appears on one side of the shuttle valve, the disc moves to the other side and seals this inlet. (1) When valve 2 is pressed and valve 1 released, the disc in the shuttle valve would seal the inlet from valve 1 and allow air to the SA cylinder from valve 2 (1)</p>	6	

Question		Answer	Marks	Guidance
3	(a)	System Input – Pre-amplifier (1) System Output – Power amplifier (1)	2	
	(b)	Microphone (1) Loudspeaker (1)	2	
	(c)	Pre-Amplifier - amplifies the small audio signal (voltage) from the microphone (1) Tone Control - adjust the audio signal ie adjusts the balance of high and low Frequencies (2) The volume control adjusts the strength of the signal (2) Power Amplifier - increases the strength (power) of the audio signal (1)	6	
4	(a)	A monitoring system in systems engineering is a process within a distributed system for collecting and storing data. The stored data can then be analyzed as and when necessary	2	
	(b)	On a factory production line In or on bulk storage tanks to monitor levels of contents On the outside of domestic or industrial buildings Monitoring the centre of gravity of an aircraft in flight Monitoring the wellbeing of people in the living environment Monitoring of regulated airborne pollutants Tracking changes in complex industrial processes	2	Accept any two correct applications

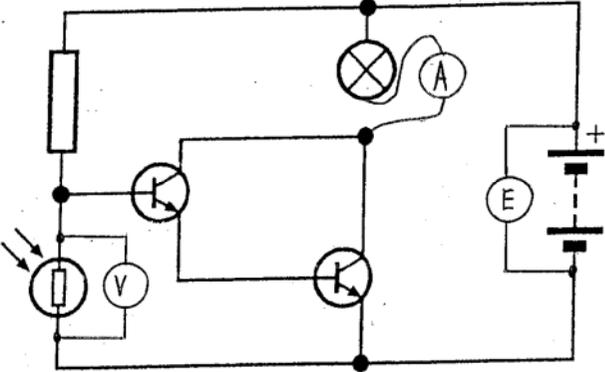
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5	<p>(a) Control theory deals with the behavior of dynamic systems. The desired output of a system is called the reference. (1)</p> <p>When one or more output variables of a system need to follow a certain reference over time, a controller manipulates the inputs to a system to obtain the desired effect on the output of the system (1)</p>	2	
	<p>(b)</p>  <p>Correctly positioned blocks and arrows (1) Correct labels (1)</p>	2	Accept any correct response
	<p>(c) Overall gain = $A / (1 + \beta A)$ (1) $= 250 / (1 + 250 / 20)$ (1) $= 250 / 13.5$ $= 18.5$ correct to 1 d.p. (1)</p>	3	
	<p>(d) Overall gain = $A / (1 + \beta A)$ $250 = 750 / (1 + 750\beta)$ (1) $(1 + 750\beta) = 750 / 250$ $(1 + 750\beta) = 3$ (1) $750\beta = 3 - 1$ $750\beta = 2$ $\beta = 2 / 750$ $= 1 / 375$ (1)</p>	3	

Question		Answer	Marks	Guidance
6	(a)	<p>A PLC is an electronic device that uses a programmable memory to store instructions and to implement functions such as logic sequencing, timing and counting in order to control machines and processes.</p> <p>The term logic is used because programming is concerned with implementing logic operations such as OR, AND, NOR and NAND, in switching circuits</p>	2	
	(b)	<p>Traffic light control High speed counters Automatic machining stations Chemical batch production Furnace temperature controller Automatic washing machines</p>	2	Accept any two correct applications
	(c)	<p>Programme memory – storage of the instructions for the logical control sequence (2)</p> <p>Data memory – storage of the status of switches, interlocks, past values of data and other working data (2)</p> <p>Output devices – these are the hardware / software drivers for the industrial process actuators, such as solenoids, valves, motors and switches (2)</p> <p>Input devices - these are the hardware / software drivers for the industrial process sensors such as switch status sensors, proximity detectors and interlock settings.</p>	6	Accept any three correct features

Question		Answer	Marks	Guidance
7	(a)	The signal processor is the element in a system that takes the output from a sensor (1) and converts it into a form that is suitable for display or onward transmission (1)	2	
	(b)	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 which causes the signal to become weaker	2	Accept any two correct responses
	(c)	A transverse mode of a beam of electromagnetic radiation is a particular electromagnetic field pattern of radiation measured in a plane perpendicular (ie transverse) to the propagation direction of the beam (2) Transverse modes occur because of boundary conditions imposed on the wave by the waveguide. For example, a radio wave in a hollow metal waveguide must have zero tangential electric field amplitude at the walls of the waveguide, and so the transverse pattern of the electric field of waves is restricted to those which fit between the walls. For this reason, the modes supported by a waveguide are quantized. The allowed modes can be found by solving Maxwell's equations for the boundary conditions of a given waveguide. (2) A mode of the electromagnetic field that involves only one component of the magnetic field and the two components of the electric field perpendicular to it; eg , the x-component of the magnetic field and y- and z-components of the electric field. (2)	6	

Question	Answer	Marks	Guidance
8	<p>(a) Simulation means that instead of having the real thing you have a computer generated lookalike which enables you to have features that represent the circuit that you are studying without having to produce it (1)</p> <p>Quicker to produce than the real thing and components can be changed very easily Components do not get damaged during construction Tests can be carried out and results verified before constructing the real thing (1)</p>	2	
	<p>(b)</p> <p>Digital signal</p>  <p>Analog signal</p> 	2	

Question	Answer	Marks	Guidance
(c)	<p>On Fig. 3 draw and label</p> <ul style="list-style-type: none"> • a voltmeter to measure the potential difference for the LDR • an ammeter to measure current flow for the signal lamp • a voltmeter to measure the electromotive force of the battery <p>Marks: Voltmeter - Correct symbol and position (LDR) (2) Ammeter - Correct symbol and position (Signal lamp) (2) Voltmeter - Correct symbol and position (Battery) (2)</p> 	6	
	Total	40	

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