Principal Learning

Engineering

Unit **F559:** Instrumentation and Control Engineering

OCR Level 3 Principal Learning

Mark Scheme for June 2015

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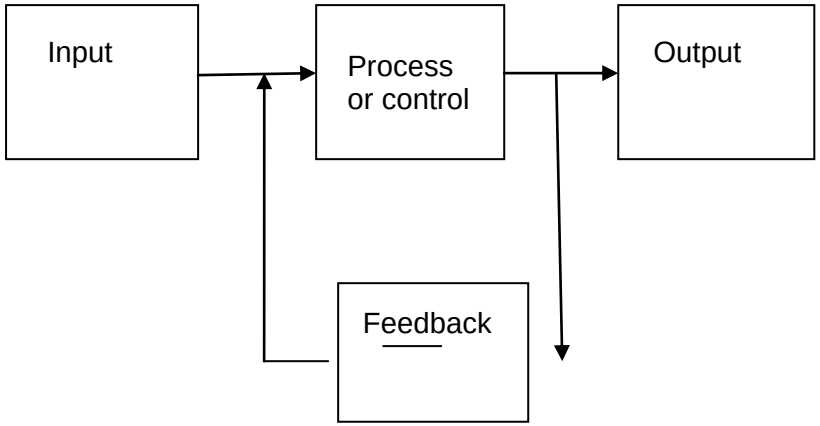
This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

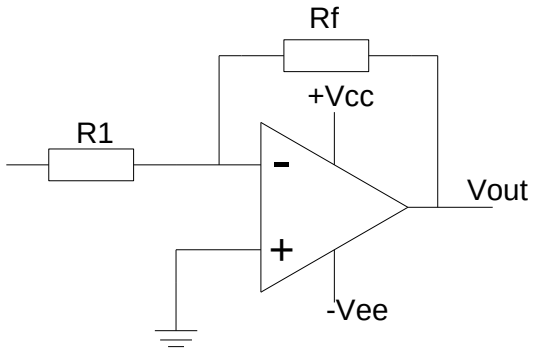
All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

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.

Question			Expected Answer	Mark	Rationale/Additional Guidance
1	(a)			[1]	Award one mark for four correctly positioned arrowheads.
1	(b)		Process or Control.	[1]	
2			Signal lamp/Filament lamp/Buzzer/Bell/Motor/Light Emitting Diode/Liquid Crystal Display/LED 7 segment Display/Solenoid/Relay, speaker, printer, heating coil.	[2]	Award one mark for each correct output device named. Accept other correct responses.
3			Pressure sensor Keypad.	[2]	Award one mark for each correct input device.
4			A two-input multiplexer is a device that has two input signals, analogue or digital, which are converted into a one signal output.	[1] [1]	Award one mark for reference to converted and one mark for a one signal output.

Question			Expected Answer	Mark	Rationale/Additional Guidance
5			Thermistor Strain Gauge Load Cell	**[1]** **[1]** **[1]**	
6			Force = pressure x cross-sectional area = 2000 x 0.004 or 2000000 x 0.004 = 8 kN = 8000N	 **[1]** **[1]**	Award two marks for correct numerical answer with or without working.
7			To calculate **overall** gain.	**[1]**	.Accept any statement referring to negative feedback.
8			3/2 directional control valve. Non-return valve / one way flow valve	**[1]** **[1]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
9				[2]	Award one mark for a correct operational amplifier and one mark for the correct position of the two resistors.
10			Different entry code combinations. Panic button . Weather proof and vandal resistant. Secure push button terminal. Illuminated buttons with fade option Zone buttons LCD Screen / digital display Key entry - pin or password	[2]	Award one mark for each correct feature named. Accept other correct responses.
			Section A Total	[20]	

SECTION B

Question			Expected Answer	Mark	Rationale/Additional Guidance
1	(a)	(i)	Toluene. Hydrogen.	[1] [1]	
1		(ii)	Benzene Mixed gas Toluene	[1]	Accept any one answer from the list given.
1		(iii)	Toluene	[1]	
1	(b)		Overall gain G = A/(1 - βA) where A open loop gain Cross multiply: G(1 - βA) = A Open bracket: G - GβA = A Add both sides by GβA: G = A + GβA Take out common factor A: G = A(1 + Gβ) Divide both sides by (1 + Gβ): A = G/(1 + Gβ) A = 10^3/ (1 +10^3 x 1 x 10^{-3}) = 10^3/ (1 + 1) = 500	[1] [1] [1] [1] [1] [1]	
			Total	[10]	

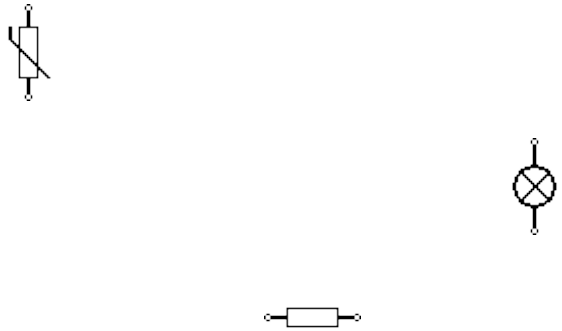
Question			Expected Answer	Mark	Rationale/Additional Guidance
2	(a)		**Light Sensor -** an input device that detects light levels (1) and converts it into an electrical signal (1). **Signal Processor –** an element that takes the output from the sensor (1) and converts it into a form which is suitable for data presentation (1). **Data presentation –** is where data is displayed, recorded or transmitted (1) to a control system (1). **Transducer –** an element which converts a change in some physical variable (1) into a related change in some other physical variable (1).	**[8]**	Award two marks for each correct explanation.
2	(b)	(i)	Thermocouple	**[1]**	
		(ii)	Bourdon Gauge	**[1]**	
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
3	(a)		Single acting cylinder has one vent and a spring. Double acting cylinder has two vents without the use of a spring. A single-acting cylinder out-strokes by means of air and in-strokes by means of an integrated spring. With a double-acting cylinder, movement in both directions is by means of air.	[2]	Award one mark for each correct difference stated.
3	(b)		**Function of each part.** Filter – can remove impurities from compressed air before it is fed to the pneumatic components. Pressure regulator – to stabilise the pressure and regulate the operation of pneumatic components. Lubricator – To provide lubrication for pneumatic components so that parts do not seize up.	[1] [1] [1] [1] [1] [1]	Accept answers referring to manually handled water separator Accept display working air pressure
3	(c)		5 - The number of ports. 2 – The number of positions / ways	[1] [1]	
			Total	[10]	

Question			Expected Answer	Mark	Rationale/Additional Guidance
4	(a)			[5]	

Definition	
Comparing the speed of a direct current motor with desired speed	Operational Amplifier.
Measuring the temperature of car engine coolant.	Thermistor.
Controlling the rate at which a liquid passes through a pipe.	Orifice Plate
Controlling the upward or downward movement of a robotic arm.	Programmable Logic Controller.
Identifying faulty components moving along a conveyor belt.	Photoelectric sensor.

Question			Expected Answer	Mark	Rationale/Additional Guidance
	(b)		**Proportional mode** produces a control action that is directly proportional to the error.	[1]	
			Proportional plus derivative mode produces two control actions, one which is proportional to the error and one that is proportional to the rate at which the error is changing.	[2]	
			Proportional plus integral mode produces two control actions, one which is proportional to the error and one that is proportional to the integral of the error.	[2]	
			Total	[10]	

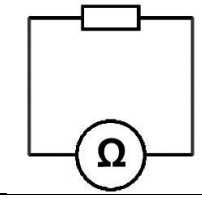
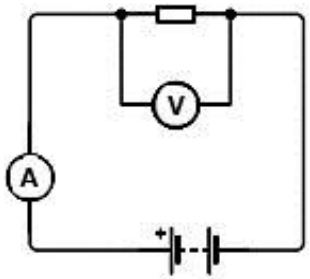
Question			Expected Answer	Mark	Rationale/Additional Guidance
5	(a)		The NTC thermistor has the property where the resistance decreases (1) with increasing temperature (1) or vice versa.	[2]	
5	(b)	(i)	Thermistor symbol on the left hand side of the diagram. Signal lamp on the right hand side. Base resistor in the centre. 	[3]	Award one mark for each correctly positioned symbol.

Question			Expected Answer	Mark	Rationale/Additional Guidance
5	(b)	(ii)	During warm or hot conditions the thermistor resistance will drop. The voltage across the base resistor needs to be above 0.6V. Current will flow through the base resistor into the base of the transistor, out of the emitter to the 0V point. The current has been amplified. So by design, it is large enough to light the signal lamp.	[1] [1] [1] [1] [1]	
			Total	[10]	

Question			Expected Answer	Mark	Rationale/Additional Guidance
6	(a)		A servomechanism, sometimes shortened to servo, is an automatic device that uses error-sensing negative feedback to correct the performance of a mechanism and is defined by its function. It usually includes an in-built encoder.	[2]	Award one mark for reference to error sensing negative feedback. Award one mark for reference to correcting the performance of a mechanism.
6	(b)		**Servo control:** Factory production lines Electric traction units Computer disc drives Music and games systems Robotics **Temperature control:** Heat exchangers Process vessels High temperature fail safe control Closed loop control / thermostat **Positional control:** DC motor being used in a pen plotter Radio control servos Aerial rotators Power assisted steering systems Rotary potentiometer CNC control	[1] [1] [1]	Award one mark for each correct answer.

Question			Expected Answer	Mark	Rationale/Additional Guidance
6	(c)		Servo control-Temperature control-Positional control. For Diagram – one mark for diagram, one mark for correct labelling.	[5]	Award two marks for correctly labelled diagram and three marks for a correct description of type of control system.
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
7	(a)		Designed to detect intrusion – unauthorized entry Designed to deter intrusion – visible alarm Protection against burglary (theft) or property damage Personal protection against intruders Some systems automatically record the activities of intruders and could be used as evidence in court cases Some alarms interface to access control systems for electrically locked doors. Quality control	[3]	Award one mark for each correct point made.
7	(b)		Rejection for parts out of tolerance. Alarm e.g. buzzer Yes or No screen prompts to programme individual setting Factory preset programming should suit 90% of purposes Uncomplicated system for adding on any other desirable features that might be needed after the production line has been used. Video camera Provision for feedback	[3]	Award one mark for each correct feature.
7	(c)		Detection of an outbreak of fire Alert to an increase in temperature in a refrigeration plant. Detection of escape of radiation Alert to release of chemicals into the atmosphere. Wireless remote monitoring system on a landfill flare station Goods on a conveyor belt.	[2]	Award one mark for each correct application. Allow reference to quality control.
7	(d)		Digital cameras use an embedded systems electronics The sensor known as a CCD in order to capture a digital photo. The CCD monitors light and colour and turns it into digital data This sensor replaces the old film rolls used by traditional cameras.	[2]	Award one mark for the correct name of the embedded system. Award one mark for any other point explaining the system.
			Total	**[10]**	

Question			Expected Answer	Mark	Rationale/Additional Guidance
8	(a)		Ammeter – Digital or analogue Cathode Ray Oscilloscope Logic probe Multimeter Ohm-meter Signal Generator Voltmeter – Digital or analogue	[4]	Award one mark for each correct instrument.
8	(b)	(i)		[2]	Award one mark for the use of a multimeter or ohm-meter. Award one mark for the correct positioning of the instrument.
	(b)	(ii)			Award one mark for the correct positioning of the: Cell Voltmeter Ammeter. Accept other alternative correct positions. Award one mark for the three correct graphical symbols.
			Total	**[10]**	

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