OCR
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Principal Learning

Engineering

OCR Level 3 Principal Learning in Engineering **H811**

Mark Schemes for the Units

January 2010

H811/MS/R/10J

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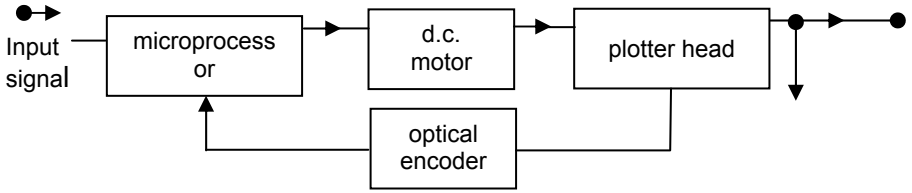
Principal Learning

OCR Level 3 Principal Learning in Engineering H811

MARK SCHEMES FOR THE UNITS

F559 Instrumentation and control engineering

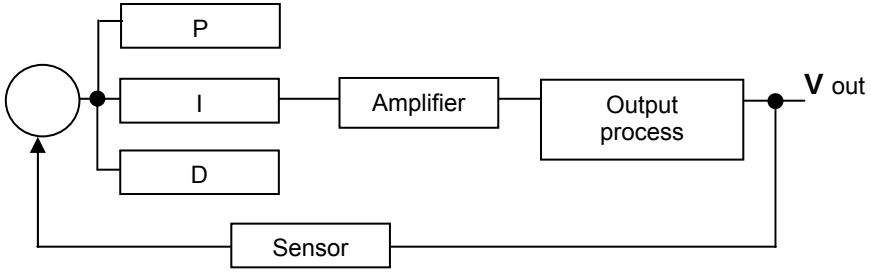
Question	Expected Answer	Mark	Rationale
Section A			
1	**For a system, explain what is meant by the term input.** A basic system consists of three blocks – an input, control device and an output. The input is a device which converts one variable into another.	**[1]** **[1]** **[Total 2]**	
2	**Draw a block diagram to represent a system that has feedback.** There are many answers to this question. One example is provided of a positional control system. **Fig 1**  Accept any correct response One mark for all correctly positioned blocks and one mark for all correctly positioned arrows.	**[2]**	Arrows must be on feedback loop
3	**Name two input devices in a control system.** Potentiometer Thermistor Light dependent resistor Potential divider circuits. Strain gauge One mark for each correct response. Accept any two correct responses. Accept another suitable input device.	**[2]**	

Question			Expected Answer	Mark	Rationale
4			**Name two output devices in a control system.** Light emitting diode, bell, motor, heater, speaker, 7 segment display. One mark for each correct response. Accept any two correct responses. Accept another suitable output device.	**[2]**	
5			**Explain what is meant by an operational amplifier controller.** The op amp controller is a signal processing element. This element takes the output from the sensor and converts it to a form which is suitable for display or onward transmission.	**[1]** **[1]** **[Total 2]**	
6			**Explain the difference between an analogue voltmeter and a digital voltmeter.** The reading from an analogue voltmeter involves a pointer and a scale. A digital voltmeter gives a direct number reading.	**[1]** **[1]** **[Total 2]**	
7			**Explain how a computer package is used to test a digital instrumentation and control circuit.** A number of different correct descriptions and diagrams can be given as a solution to this question. An example is provided below: This package is Spice V5.0 electronic design software using a distortion meter. The distortion meter measures the distortion generated within a circuit, usually an amplifier. An input and an output node are specified. An input and output node must be chosen, as the distortion meter needs an input to inject a pure signal, which will compare the output's signal against in calculating the distortion in the output signal.	**[1]**	

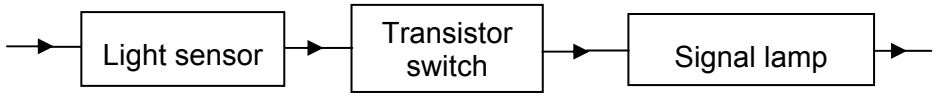
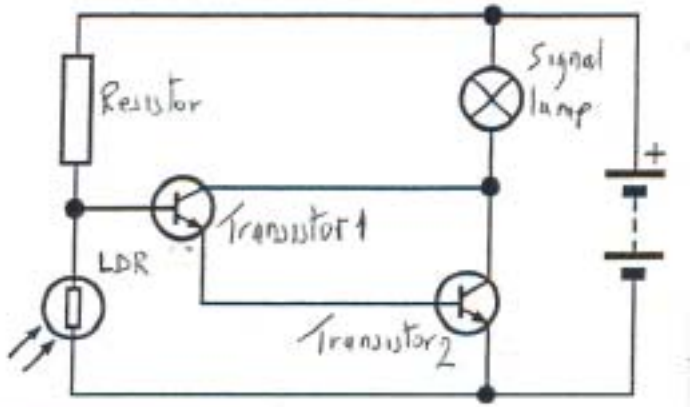
Question			Expected Answer	Mark	Rationale
			Second a test frequency needs to be entered (usually 1kHz for audio circuits). The amplitude and offset of the test signal can also be set. The option to display the results as a percentage or in dBs is quite straight forward. One percent distortion equals the distortion's contribution to the output signal being – 40dB down in amplitude relative to the output signal. The bar's length expands and contracts with the distortion being measured, which makes it an analogue readout. When the measured current exceeds the distortion meter's range, the bar changes colour from its normal blue to red. Pressing the "Auto" button overrides the fixed range and auto adjusts the range to twice the highest distortion reading it sees.	**[1]** **[Total 2]**	
8			**Name two devices that measure fluid flow in a control system** Venturi tube Orifice plate Rotameter Turbine meter One mark for each correct response. Accept any two correct responses.	**[2]**	Allow flow meter

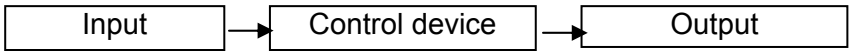
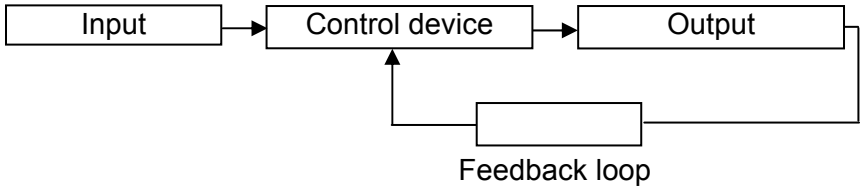
Question			Expected Answer	Mark	Rationale
9			**Complete the table below by selecting a sensor output for each of the situations.** **Choose from the following list:** **Displacement, resistance, inductor, capacitance, voltage.** Voltage/resistance/displacement/voltage: Voltage = Thermocouple Resistance = Strain gauge Displacement = Bourdon gauge Voltage = Linear variable differential transformer One mark for each correct response.	**[4]**	**Section A TOTAL 20 marks**

Question			Expected Answer	Mark	Rationale
Section B					
1	(a)		**Give two practical applications of a PID (proportional plus integral plus derivative controller).** Examples of practical applications are: temperature control, tension control in a belt system, humidity control, pressure control, pH control, regulation of speed. Accept any two correct responses.	**[2]**	
	(b)		**Explain, using examples of how PID controllers have had an impact on instrumentation and control systems.** Relatively simple to use High performance with low maintenance costs Higher product quality at reduced costs Faster than previous controllers Easy to tune Accept any three correct responses.	**[3]**	

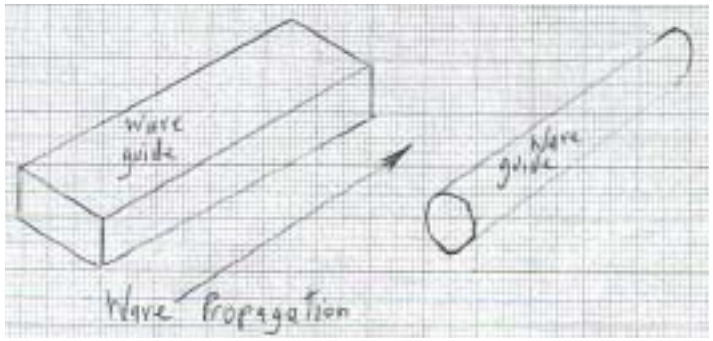
Question	Expected Answer	Mark	Rationale
(c)	**Describe, in detail, with the aid of a labelled diagram, how a PID could be used in a control system.** A number of different correct descriptions and diagrams can be given as a solution to this question. An example is provided below: **Amplifier C** **Fig 2**  One mark for diagram and 1 mark for labels Description: A typical PID temperature controller application could be to continuously vary a regulator which can alter a process temperature. This may be a pulsed switching device for electrical heaters or by opening and closing a gas valve. A heat only PID temperature controller uses a reverse output action, ie more power is applied when the temperature is below the set point and less power when above. PID control for injection and extrusion applications often employ additional cooling control outputs and usually require multiple controllers. A PID controller (sometimes called a three term controller) reads the sensor signal, normally from a thermocouple, and converts the measurement to engineering units eg Degrees C. It then subtracts the measurement from a desired set point to determine an error.	**[1]** **[1]** **[1]** **[1]** **[1]** **[Total 10]**	

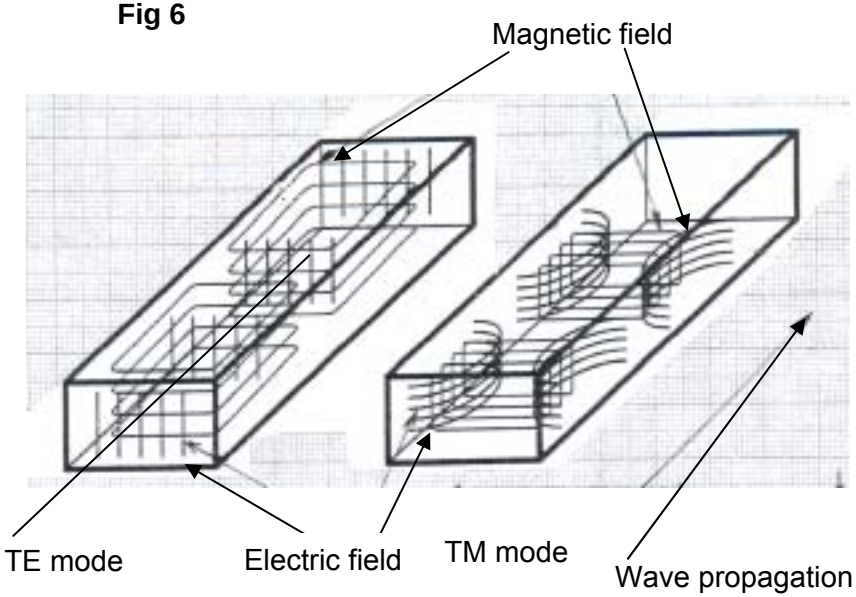
Question			Expected Answer	Mark	Rationale
2	(a)		**State two practical applications of an LDR (light dependent resistor) in a control circuit.** Security lighting Lighting for roadworks Alarm systems Water pollution indicator. Accept any two correct responses.	**[2]**	
	(b)		**Explain how a light dependent resistor works.** In darkness the resistance of an LDR is high. In light its resistance is low. When the LDR is illuminated it changes light into electrical energy.	**[1]** **[1]** **[1]**	

Question	Expected Answer	Mark	Rationale
(c)	**Describe, with the aid of a labelled block diagram and a labelled circuit diagram how a light dependent resistor can be used in control applications.**   Fig 3 Block diagram – 1 mark for blocks and labels Circuit diagram – 1 mark for the diagram and 1 mark for the labels. During daylight the lamp in the circuit will not light but as soon as darkness descends the LDR resistance goes high and current flows. This current goes into the base of the first transistor out of the emitter into the base of the second transistor and out of the emitter to the negative of the battery. The base currents switch on the transistor and, if the collector currents are large enough, the lamp lights.	**[3]** **[1]** **[1]** **[Total 10]**	

Question			Expected Answer	Mark	Rationale
3	(a)		**Give two practical applications of circuits that make use of a closed loop System.**		
			Control of: temperature position servomechanisms Accept any two correct responses.	 **[2]**	Allow manual feedback
	(b)		**Explain with the aid of labelled diagrams the difference between an open loop system and a closed loop system.** **Fig 4** Open loop  Closed loop  Diagram – 1 mark for blocks and labels. The difference between open loop and closed loop is that the open loop is a linear system and the closed loop has a feedback component included. Feedback makes use of a sensor to detect changes at the output and to feed information back to the control device, which may then modify the input.	 **[1]** **[1]** **[1]**	

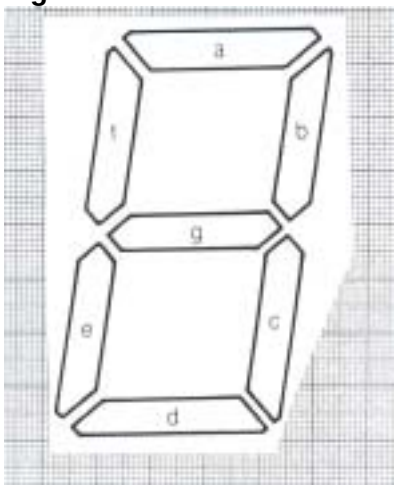
Question	Expected Answer	Mark	Rationale
(c)	**An amplifier has an overall gain of 10^3 with a feedback fraction of 0.9×10^{-3}. Calculate the open loop gain when negative feedback is applied.**		
	Overall gain $G = A/(1 + \beta A)$ where A open loop gain		
	Cross multiply: $G(1 + \beta A) = A$		
	Open bracket: $G + G\beta A = A$	**[1]**	
	Subtract both sides by $G\beta A$: $G = A – G\beta A$		
	Take out common factor A: $G = A(1 – G\beta)$	**[1]**	
	Divide both sides by $(1 – G\beta)$: $A = G/(1 – G\beta)$	**[1]**	
	$A = 10^3 (1 – 10^3 \times 0.9 \times 10^{-3}) = 10^3 (1 – 0.9) = 10^3/0.1 \times 10^3 = 10000$	**[1]**	
	Marks will be awarded for error carried forward.	**[Total 10]**	

Question			Expected Answer	Mark	Rationale
4	(a)		**State two advantages of using a wave guide as compared to a two conductor type cable.** Waveguides are considerably less complicated than a two conductor cable in their manufacture and maintenance. Moisture is not a severe problem as with coaxial cables. Do not need gas filling. There are no concerns with proper conductor-to-conductor spacing, or of the consistency of the dielectric material, since the only dielectric in a waveguide is air. Accept any two correct responses.	**[2]**	
	(b)		**Explain, with the aid of a labelled diagram, what is meant by a wave guide when related to signals.** **Fig 5**  Labelled diagram – 1 mark for diagram and labels A waveguide is a special form of transmission line consisting of a hollow, metal tube. The tube wall provides distributed inductance, while the empty space between the tube walls provide distributed capacitance.	**[1]** **[1]** **[1]**	

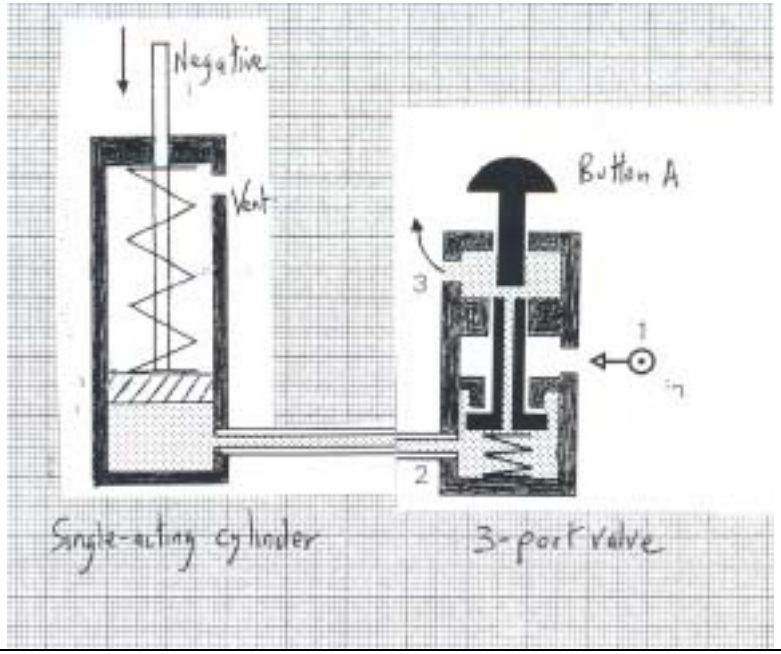
Question			Expected Answer	Mark	Rationale
	(c)		**Explain, with the aid of a labelled diagram, the difference between a transverse electric mode and a transverse magnetic mode of propagation of a signal.** **Fig 6**  TE mode diagram and labels – 1 mark TM mode diagram and labels – 1 mark When an electromagnetic wave propagates down a hollow tube, only one of the fields – either electric or magnetic – will actually be transverse to the wave's direction of travel. The other field will "loop" longitudinally to the direction of travel, but still be perpendicular to the other field. Whichever field remains transverse to the direction of travel determines whether the wave propagates in *TE* mode (**T**ransverse **E**lectric) or *TM* (**T**ransverse **M**agnetic) mode.	**[1]** **[1]** **[1]** **[1]** **[1]** **[Total 10]**	

Question			Expected Answer	Mark	Rationale
5	(a)		**Name two applications for a control system.** Setting the dials on an automatic washing machine In a bottling plant the bottles are automatically filled to the required level A packaging machine is used to select items from a conveyor belt A CNC machine tool is used to automatically machine a workpiece. Accept any two correct responses.	**[2]**	
	(b)		**Explain what is meant by a control system** The basic building blocks of any control system are input, control and output A control system is a system which for a particular input or inputs is used to control its output to some particular value or give a particular sequence of events or give an event if certain conditions are met	**[1]** **[1]** **[1]**	

Question			Expected Answer	Mark	Rationale
	(c)		**Describe, in detail, the control system shown in Fig 1 which is being used to control the pressure of a fuel supply system.** Fuel from the tank is pumped through a filter to the injectors. The pressure in the fuel line is controlled to be above the manifold pressure by a regulator valve. The valve has a diaphragm which presses a ball plug into the flow path of the fuel. The diaphragm has the fuel pressure acting on one side of it and on the other side is the manifold pressure and a spring. If the pressure is too high, the diaphragm moves and opens up the return path to the fuel tank for the excess fuel. The fuel pressure is adjusted to return it to its required value.	**[1]** **[1]** **[1]** **[1]** **[1]** **Total 10]**	
6	(a)		**Name two types of display unit other than a seven-segment display.** analogue and digital voltmeter analogue and digital ammeter ohmmeter cathode ray oscilloscope dot matrix noise meter avometer LCD Accept any two correct responses.	**[2]**	

Question			Expected Answer	Mark	Rationale
	(b)		**Explain, using examples of the advantages of a seven-segment display for use in an instrument** Advantages: easily made up from LED's relatively low cost reliable easy to interface range of shapes and sizes available long life high operating speed easy to make a multiplexed assembly available in different colour Accept any three correct responses.	**[3]**	
	(c)		**Describe, in detail, with the aid of a labelled diagram, the principle of operation of a seven- segment display.** **Fig 7**  		

Question			Expected Answer	Mark	Rationale
			One mark for diagram and 1 mark for letters A seven – segment display unit is made up of seven light emitting diodes in an arrangement that provides the digits 0 to 9 to be formed. Each LED is labelled a to g. The individual LED's may be lit in combinations which form the required digit. A decimal point can be included either on the right hand or left hand of the display. When a typical current of 10 mA passes through the diode it emits light. Each diode has an anode lead at which the current enters and a cathode at which it leaves. All seven anodes are joined together to form a common anode. Likewise a common cathode can also be used.	**[2]** **[1]** **[1]** **[1]** **[Total 10]**	
7	**(a)**		**State two practical applications that uses a pneumatic cylinder as a linear actuator.** Up/down control of doors Tipper lorry Window opener Piston speed control Conveyor belt Rock drill Part of a component labelling system Accept any two correct applications.	 **[2]**	

Question			Expected Answer	Mark	Rationale
	(b)		**A pneumatic cylinder has an internal diameter of 0.06 m and a pressure difference of 500 kPa. Calculate the force acting on the cylinder using the formula Force (F) = pressure (P) x area (a).** $a = \pi d^2/4 = (\pi \times 0.06^2)/4 = 2.827 \times 10^{-3}\ m^2$ Force = Pa $= 500 \times 10^3 \times 2.827 \times 10^{-3}$ = 1413.5 N	**[1]** **[1]** **[1]**	
	(c)		**Describe, in detail, with the aid of a labelled diagram, how a push-button operated 3-port valve can be used to control a single acting cylinder.** **Fig 8** 		

Question			Expected Answer	Mark	Rationale
			One mark for SA cylinder and 1 mark for 3-port valve When button A is in the off position, the spring return on the valve holds the piston tight against a seal. The main air flow is shut off from port 1. The piston in the cylinder is negative. Air trapped behind the cylinder flows into the valve at port 2. When button A is held down, the piston is forced against the spring. Main air from port 1 flows through to port 2 and into the cylinder. Air pressure forces the cylinder to go positive. Air trapped in front of the piston escapes through a vent.	**[2]** **[1]** **[1]** **[1]** **[Total 10]**	
8	**(a)**		**State two practical applications that use a monitored control system.** Garage forecourt Hazardous process Power station – generation of electricity Accept any two correct applications.	 **[2]**	
	(b)		**Explain why it is often necessary to monitor a control system.** 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.	 **[1]** **[1]** **[1]**	

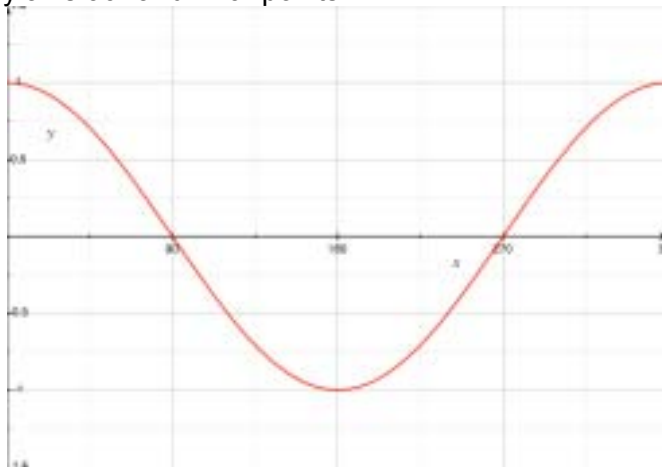
Question			Expected Answer	Mark	Rationale
	(c)		**Describe, in detail, with the aid of a labelled block diagram, the monitoring control system for an engineering production line of your choice.** A number of different correct descriptions and diagrams can be given as a solution to this question. An example is provided below of a Gypsum board production line: Fig 9 – 1mark for labelled block diagram. The production line uses the advanced Distributed Control system (DCS). The process divided into five parts, distribution shaping, central control, automatic board-enter, Auto board-exit and drying kiln temperature control. The parts are monitored by DCS monitor system all the time having five parts shown in the block diagram. Preparation shaping machine: screw conveyer, pastes pump, metering pumps, feeding screw conveyer, slurry mixer, forming station mixer, platform shaking machine and ring belt forming machine. Centralized control system: deals with data acquisition and processing also monitors the shaping and drying process. Auto board-enter system: auto board cutter, belt conveyor, roller, board turnover machine, kiln enter distributor, faster board-enter, through PLC auto control, the process of cutter, speed-up, kiln enter of gypsum board is finished	**[1]** **[1]** **[1]**	

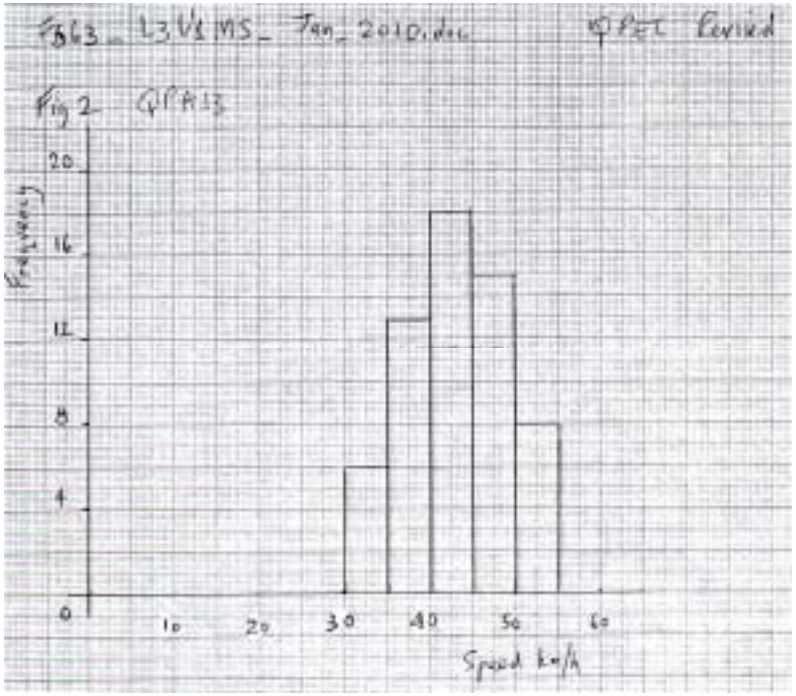
Question			Expected Answer	Mark	Rationale
			Automatic Finished board system: board-exit from dryer, layer-distributor, horizontal belt conveyor, roller, cutter and stacking machine. All controlled by a central system through sensor, PLC, touch screen and control panels. Cutting, taping and stacking are finished automatically. Drive, temperature control, and hot air cycling system: Control is through a remote meter and humidity sensor system.	**[1]** **[1]** **[Total 10]**	

F563 Mathematical Techniques and Appliations for Engineers

Section A

Question	Expected Answers	Marks	Rationale
1	$(x - 5)(x - 2) = x^2 - 2x - 5x + 10$ [1] $= x^2 - 7x + 10$ [1]	**[2]**	
2	$x^2 + 3x – 40 = (x + 8)(x – 5)$ $(x + 8)$ [1] $(x – 5)$ [1]	**[2]**	
3	$(x + 3)/5 - (x + 6)/2 = (2x + 6 -5x – 30)/10$ [1] $= (-3x – 24)/10$ [1]	**[2]**	
4	$3(x - 2) = 4x + 5$, $3x – 6 = 4x + 5$ [1] $4x – 3x = -6 -5$ $x = -11$ [1]	**[2]**	
5	Length of arc (s) = $(\pi x^0 r)/180$ therefore $x^o = 180\ s/\pi\ r$ [1] $= (180 \times 480)/ (\pi \times 100)$ $= 275$ [1]	**[2]**	
6	$\sin 36^o = 75/b$ therefore $b = 75/ \sin 36^o$ [1] $= 75/0.5878$ $= 127.6$ mm correct to 1 dp [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
7	Fig.1 Graph of y = cos θ Marks: x axis +1 and -1 points [1] y axis 90° and 270° points [1] 	**[2]**	
8	$\sin^2 x + \cos^2 x = \sin^2 150 + \cos^2 150$ [1] $= 0.25 + 0.75$ [1] $= 1$ QED	**[2]**	
9	$y = 5x^4 - 4x^3$ $dy/dx = 20x^3 – 12x^2$ $20x^3$ [1] $- 12x^2$ [1]	**[2]**	
10	$y = 4e^x + \ln(2x)$ $dy/dx = 4e^x + 1/x$ $4e^x$ [1] $+ 1/x$ [1]	**[2]**	
11	$\int (5x^4 + 8x^3 + 3x^2)\ dx = x^5 + 2x^4 + x^3 + C$ $x^5 + 2x^4$ [1] $+ x^3 + C$ [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
12	$\int 8 \sin 4x.\, dx = (-8 \cos 4x)/4 + C$ [1] $= -2 \cos 4x + C$ [1]	**[2]**	
13	Histogram -  Marks: Frequency and speed axes [1] Five correct positions [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
14	Ungrouped data given is 7, 11, 9, 14, 10, 12 and 8 Rearranged becomes 7, 8, 9, [10], 11, 12, 14 showing median as 10 [1] Mean = (7 + 11 + 9 + 14 + 10 + 12 + 8)/7 = 71/7 = 10.143 correct to 3dp [1]	**[2]**	
15	Probability that the lathe is being used = 7/8 [1] = 87.5% [1]	**[2]**	

Section B

Question	Expected Answers	Marks	Rationale
1 (a)	Given $T = 2\pi \sqrt{(L/g)}$ When L = 5 m and g = 9.81 ms^{-2} Then Given $T = 2\pi \sqrt{(5/9.81)}$ [1] $= 4.49$ s correct to 2 dp [1]	**[2]**	
(b)	Given $T = 2\pi \sqrt{(L/g)}$. Divide both sides by 2π then $T/2\pi = \sqrt{(L/g)}$ Take the square of both sides then $(T/2\pi)^2 = L/g$ [1] Open the bracket then $T^2/4\pi^2 = L/g$ Multiply both sides g then $L = gT^2/4\pi^2$ [1] When T = 4 s and g = 9.81 ms^{-2} then $L= (9.81 \times 4^2)/4\pi^2 = 3.98$ m correct to 2 dp [1]	**[3]**	
(c)	Given $R_1/R_2 = (1 + \alpha t_1)/(1 + \alpha t_2)$ Cross multiply then $R_1(1 + \alpha t_2) = R_2(1 + \alpha t_1)$ [1] Open the brackets then $R_1 + R_1 \alpha t_2 = R_2 + R_2 \alpha t_1$ [1] Reorganise equation then $R_1 \alpha t_2 - R_2 \alpha t_1 = R_2 - R_1$ [1] Take α and make a bracket then $\alpha (R_1 t_2 - R_2 t_1) = R_2 - R_1$ Divide both sides by $(R_1 t_2 - R_2 t_1)$ then $\alpha = (R_2 - R_1)/(R_1 t_2 - R_2 t_1)$ [1] So $\alpha = (98 - 100)/[(100 \times 70) - (98 \times 30)] = -4.926 \times 10^{-4}$ [1]	**[5]**	
			[Total:10]

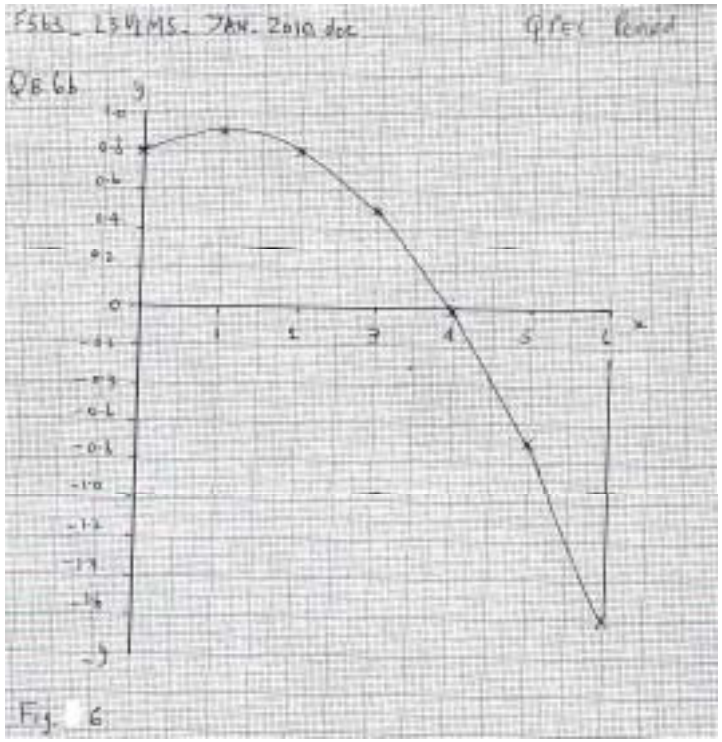
Question	Expected Answers	Marks	Rationale
2 (a)	Given equation is E = aW + b When E = 16 N, W = 120 N and when E =34 N, W =480 N So 16 = 120a + b Eq. (1) [1] 34 = 480a + b Eq. (2) [1]	[2]	
(b)	Multiply Eq. (1) x 4 64 = 480a + 4b Eq. (3) [1] Subtract Eq.(2) from Eq.(3) So 30 = 3b [1] Then b = 30/3 = 10 [1] To find 'a' substitute b = 10 into Eq. (1) So 16 = 120a + b Then 16 = 120a + 10 Then 120a = 16 - 10 120 a = 6 So a = 6/120 = 0.05 [1]	[4]	
(c)	Use Eq. (1) to find load when the effort is 42 N So E = 0.05W + 10 42 = 0.05W + 10 [1] Then 0.05W = 42 – 10 = 32 So W = 32/0.05 = 640 N [1]	[2]	
(d)	Use Eq. (1) to find the effort when the load is 300 N So E = 0.05W + 10 [1] E = (0.05 x 300) + 10 = 25 N [1] Accept any alternative method of solution	[2]	
			[Total:10]

Question	Expected Answers	Marks	Rationale
3 (a)	Apply the sine rule to find angle ACB b/ sin B = c/ sin C [1]	[1]	
(b)	so sin C = (c sin B)/b sin C = (15 sin 52^o)/18 = 0.6567 [1] C = $\sin^{-1}$ 0.6567 = 41.05^o = 41^o to the nearest degree [1]	[2]	
(c) (i)	Apply the cosine rule to find angle CAB Cos A = $(b^2 + c^2 – a^2)/2bc$ [1] = $(100^2 + 210^2 – 170^2)/(2 \times 100 \times 210)$ [1] = 0.6 A = $\cos^{-1}$ 0.6 = 53.13^o = 53^o to the nearest degree [1]	[3]	
(ii)	To calculate x use the right angle triangle in Fig.3 Angle x = 90 – 53.13 = 36.87^o [1] sin 36.87 = x/100 [1] so x = 100 sin 36.87 = 60 mm to 2 sf [1] Accept any alternative method of solution	[3]	
(iii)	To calculate y use the right angle triangle in Fig. 3 Cos 36.87 = y/100 [1] y = 100 cos 36.87 = 80 mm to 2sf [1] Accept any alternative methods of solution	[2]	
			[Total:10]

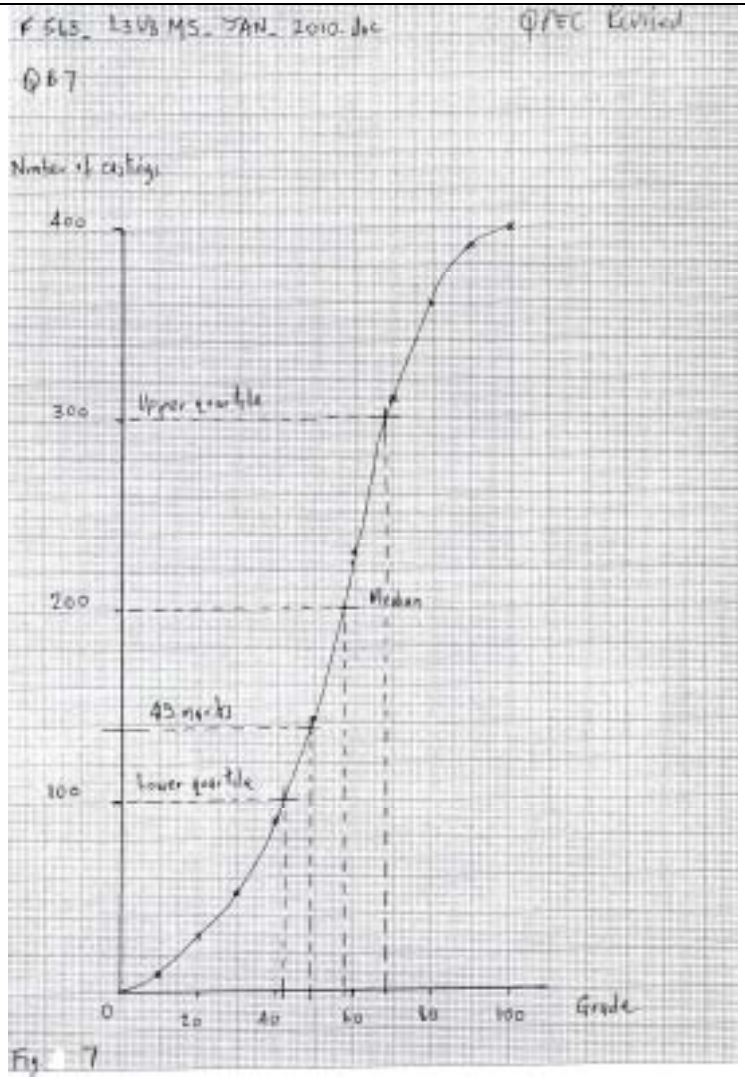
Question	Expected Answers	Marks	Rationale
4 (a) (i)	Use triangle CAD in Fig. 4 Length CD = 410 – 50 = 360 m Length AD = 375 + 625 = 1000 m [1] Angle A = $\tan^{-1}(360/1000) = 19.8^{o}$ [1]	**[2]**	
(ii)	Use triangle BAE in Fig. 4 tan 19.8 = EB/375 EB = 375 tan 19.8 = 135 m [1] Height of pylon B = 135 + 50 = 185 m [1] Accept any alternative method of solution	**[2]**	
(iii)	cos 19.8 = 1000/AC [1] AC = 1000/ cos 19.8 = 1062.8 m [1] Accept any alternative method of solution	**[2]**	
(iv)	actual length of the cable if 8% of the straight length is added for sagging = 1062.8 + 8% 0f 1062.8 = 1062.8 +85.02 = 1147.82 m [1]	**[1]**	

Question	Expected Answers	Marks	Rationale
(b)	Inspect the triangle in Fig. 5 then: sin A = a/c, cos A = b/c and tan A = a/b Given item: sin A cos A (1 + $\tan^2$A) Becomes (a/c) (b/c) [(1 + a^2/b^2)] [1] Becomes (a/c) (b/c) [($a^2 + b^2$)/ a^2] Pythagorus $a^2 + b^2 = c^2$ Then (a/c) (b/c) [($a^2 + b^2$)/ a^2] = (a/c) (b/c)[(c^2/ a^2) [1] = b/a = tan A [1]	**[3]**	
			[Total:10]
(5)	The angle θ radians turned through by a flywheel in t seconds is give by: θ = $t^3 – 8t^2 + 16t + 20$ Angular velocity (ω) = dθ/dt = $3t^2 – 16t + 16$ [1]	**[1]**	
(a)	When t = 4s then dθ/dt = $3(4)^2 – 16(4) + 16$ [1] = 0 i.e Stationary [1]	**[2]**	
(b)	Angular velocity (ω) = dθ/dt = $3t^2 – 16t + 16$ Angular acceleration (α) is dω/dt = 6t – 16 [1] When t = 6s then angular acceleration dω/dt = 6(6) – 16 = 20 rad s^{-2} [1]	**[2]**	
(c)	Ues dω/dt = 6t – 16 to find the time when the angular acceleration is zero So 0 = 6t -16 6t = 16 [1] t = 16/6 = 2.67 s correct to 2 dp [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
(d)	Use $d\theta/dt = 3t^2 - 16t + 16$ to find the time when the angular velocity is zero So $3t^2 - 16t + 16 = 0$ Solution of quadratic equation by factorisation So $3t^2 - 16t + 16 = 0$ $(3t - 4)(t - 4) = 0$ [1] Then $(3t - 4) = 0$ or $(t - 4) = 0$ [1] So $3t = 4$ then $t = 4/3$ s Or $t = 4$ s [1]	**[3]**	
			[Total:10]
6 (a) (i)	Integral = Area under the curve = $\int_2^4 6x^2\,dx$ [1]	**[1]**	
(ii)	Area under the curve = $\int_2^4 6x^2\,dx = [2x^3]_2^4$ [1] $= 2(4^3) - 2(2^3)$ $= 128 - 16$ $= 112$ square units [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
(b)	From $y = 0.1(4 – x)(2 + x)$ a table can be constructed X 0 1 2 3 4 5 6 Y 0.8 0.9 0.8 0.5 0 -0.7 -1.6  Correct x axis and correct y axis [1] Correct shape above the x axis [1] Correct shape below the x axis [1]	**[3]**	

Question	Expected Answers	Marks	Rationale
(c)	$y = 0.1(4 – x)(2 + x) = 0.1(8 + 2x – x^2)$ By inspection of the table and the graph we find that Area enclosed above the x axis = $0.1\int_0^4 (8 + 2x – x^2)\,dx$ $= 0.1[(8x + x^2 – x^3/3)]_0^4$ [1] $= 0.1(32 + 16 – 21⅓) - 0$ $= 2.66667$ [1] Area enclosed below the x axis = $0.1\int_4^6 (8 + 2x – x^2)\,dx$ $= 0.1[(8x + x^2 – x^3/3)]_4^6$ [1] $= 0.1(48 + 36 – 72) – 0.1(32 + 16 – 21⅓)$ $= 1.2 – 2.66667$ $= -1.46667$ square units (Negative sign indicates under the x axis) Total area = 2.66667 + 1.46667 = 4.13334 square units [1]	**[4]**	
			[Total:10]
7 (a)	Cumulative frequency table: Grades not more than 10 20 30 40 50 60 70 80 90 100 Frequency 11 19 22 38 52 88 80 50 30 10 Cumulative frequency 11 30 52 90 142 230 310 360 390 400 Grades not more than [1] Cumulative frequency [1]	**[2]**	

Question	Expected Answers	Marks	Rationale
(b)	 Fig. 7 Correct axes [1] Correct plot [1]	[2]	

Question	Expected Answers	Marks	Rationale
(c)	From the graph: (i) median mark = 57 ± 2 [1] (ii) Lower quartile = 42 ± 2 [1] Upper quartile = 68 ± 2 [1] (i) The number of castings with not more than 49 marks is 140 ± 2. [1] Therefore 140 ± 2 out of 400 do not make the grade [1] but 260 ± 2 out of the 400 do make the grade ie 65 ± 0.5% [1]	**[6]**	
			[Total:10]
8 (a) (i)	The probability of something happening is the likelihood or chance of it happening [1]	**[1]**	

Question	Expected Answers	Marks	Rationale
(ii)	An independent event is one in which the probability of an event happening does not affect [1] the probability of another event happening. [1]	[2]	
(b) (i)	The probability of selecting at random a resistor, p, is given by the ratio: Number of resistors/Total number of components [1] p = Number of resistors/Total number of components = 36/(36 + 39) = 36/75 [1]	[2]	
(ii)	The probability of selecting at random a capacitor, q, is given by the ratio: Number of capacitors/Total number of components q = Number of capacitors/Total number of components = 39/(36 + 39) or (1 – 36/75) = 39/75 [1]	[1]	
(c)	Total number of components = 36 + 39 = 75 The probability of randomly selecting a resistor on the first draw is 36/75 [1] There are now 35 resistors in a batch of 74. The probability of randomly selecting a resistor on the second draw is 35/74 [1] The probability of selecting a resistor on the first and second draw is (36/75) x (35/74) [1] = 0.227 [1]	[4]	
			[Total:10]

Grade Thresholds

OCR Level 3 Principal Learning in Engineering H811
January 2010 Examination Series

Unit Threshold Marks

Unit		Maximum Mark	A*	A	B	C	D	E	U
F559	Raw	60	48	42	36	30	24	18	0
	Points	14	12	10	8	6	4	2	0

No threshold data available for F563 January 2010

Specification Aggregation Results

No learners aggregated this series. Aggregation is not available for this specification until June 2010.

For additional guidance on the points awarding system, please refer to the Admin Guide for Diplomas at:
http://www.ocr.org.uk/administration/documents.html?section=general

Statistics are correct at the time of publication.

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