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General Certificate of Education (A-level)
June2013

Electronics ELEC4

(Specification 2430)

Unit 4: Programmable Control Systems

Final

Mark Scheme

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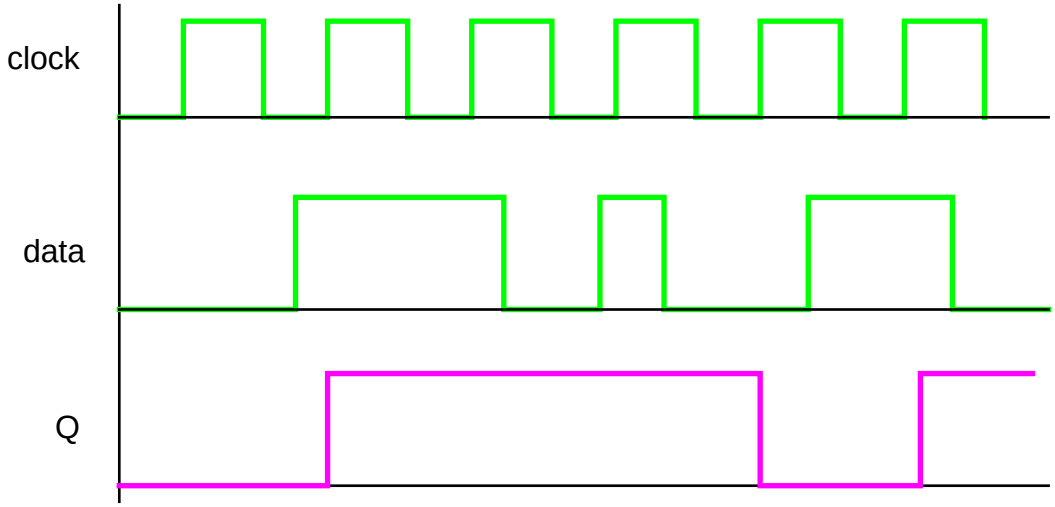
Question	Part	Subpart	Marking guidance		Mark
1	(a)		closed because the pressure in the storage tank is monitored, output affects input, there is feedback (because of pressure sensor). and negative because the pressure is kept constant		**2**
1	(b)		≈5 x 10^5 and ≈8 x 10^5Pa		**2**
1	(c)	(i)	evidence of voltage divider calculation 4V		**2**
1	(c)	(ii)	calculation of resistors in parallel (23.5k) voltage divider calculation leading to 8V		**2**
1	(c)	(iii)	calculation to show resistance of pressure sensor is 40kΩ, => pressure is ≈600 - 700kPa		**2**
2	(a)		**Uses in embedded microcontroller not raw definitions e.g. RAM – memory that can be accessed in any order** stores the operating program for the microcontroller stores information which needs to be retained when power is removed, e.g. PIN stores data temporarily while processor is operating , e.g. decoding PIN.		**3**
2	(b)		keep subsystems synchronised / timing for serial data I/O / determines speed of operation initialise system / restarts program in ROM (NOT Reset alone)		**2**
2	(c)		**During verification of PIN** ROM accessed to control processor, handle serial I/O, and contains details of PIN encryption NVM accessed to recall encrypted PIN RAM accessed to temporarily store numbers e.g. those involved with processing the PIN		**5**
3	(a)	(i)	calculation, answer 360, 390 ohms		**2**

3	(a)	(ii)	calculation, answer 1MΩ=<R_D<25MΩ		**2**

3	(a)	(iii)	single sharp pulse 0 - 5 - 0V		**1**

3	(b)		 rising edge triggered only clock triggered - correct shape		**2**

3	(c)	(i)	reference to light already going through outer slot, therefore D=1 by the time that the inner slot becomes 1, so activating the clock input		**2**

3	(c)	(ii)	rotates the other way then Q = 0 because clock rises when no light passes through outer slots		**1**

4	(a)		finishes current operation, (saves current variables to the stack), jumps to a routine to execute the interrupt request, On return, the variables are recalled from the stack and it continues where it left off.		**3**

<table>
<tr><td>4</td><td>(b)</td><td></td><td>value in PORTB decreases by 1
to a minimum value of 0</td><td></td><td>2</td></tr>
<tr><td>4</td><td>(c)</td><td></td><td>value in PORTB increases by 1
to a maximum value of 255</td><td></td><td>2</td></tr>
<tr><td>4</td><td>(d)</td><td></td><td>MOVRW PORTA, (marked with MOVRW PORTB)
ANDW 0x01 ✓
JPZ (label) ✓
MOVRW PORTB ✓</td><td></td><td>3</td></tr>
<tr><td>5</td><td>(a)</td><td></td><td>MOVW 0x00
MOVWR TRISB</td><td></td><td>2</td></tr>
<tr><td>5</td><td>(b)</td><td></td><td><table><tr><th>Display</th><th>Binary</th><th>Hexadecimal</th></tr><tr><td>1</td><td>00000110</td><td>0x06</td></tr><tr><td>2</td><td>01011011</td><td>0x5B (ecf)</td></tr><tr><td>3</td><td>01001111</td><td>0x4F</td></tr><tr><td>4</td><td>01100110</td><td>0x66</td></tr><tr><td>5</td><td>01101101</td><td>0x6D</td></tr><tr><td>6</td><td>01111101</td><td>0x7D</td></tr><tr><td>7</td><td>00000111</td><td>0x07</td></tr><tr><td>8</td><td>01111111</td><td>0x7F</td></tr></table></td><td></td><td>4</td></tr>
<tr><td>5</td><td>(c)</td><td></td><td>continually reads the value in PORTA
until a change in input is detected</td><td></td><td>2</td></tr>
<tr><td>5</td><td>(d)</td><td></td><td>1µs and 2µs
3µs (allow 333kHz)</td><td></td><td>2</td></tr>
<tr><td>6</td><td>(a)</td><td></td><td>relevant calculation leading to 63</td><td></td><td>1</td></tr>
</table>

6	(b)		feedback resistor, and +ve input to 0V three input resistors, input resistors in the ratio 1:2:4 in the range 1kΩ<R<1MΩ		**3**
6	(c)		feedback resistor, and resistor to 0V two input resistors, all given resistors the same in the range 1kΩ<R<1MΩ		**3**
6	(d)		first flash ADC converts the input to an approximate value (most significant 3 bits) this value is converted back into a voltage and subtracted from the input voltage the second flash ADC converts the remainder (least significant three bits)		**3**
7	(a)		data inputs to D data outputs from Q clock inputs joined and sensibly labelled		**3**
7	(b)		tri-state – three (output) states 0, 1 OR high, low high impedance (NOT On/Off)		**3**
7	(c)		shared data bus must be only one signal present at a time to avoid bus contention all other devices in high impedance state		**4**
8	(a)		Dome heavy, needs large torque/power, but does not need to be positioned accurately => conventional motor ✓✓ Telescope needs to be positioned accurately but does not need large force => stepper motor ✓✓		**4**
8	(b)		tolerant of large surge currents provide isolation from 'mains' voltage (NOT cheap, easy to use etc)		**2**

8	(c)		protection diode for MOSFET diode round the correct way one NC terminal to Live, opposite NO to Neutral then remaining NC terminal to Neutral, and NO to Live		**4**