GCE

Design and Technology: Systems and Control Technology

Mark scheme

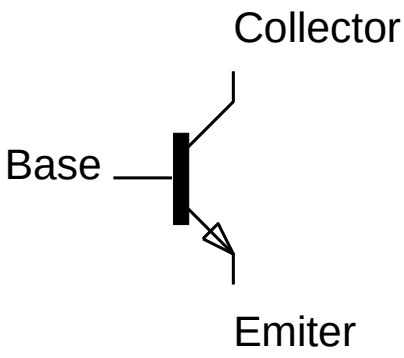
SYST1 Materials, Components and Application
June 2016

Version: 1.0 Final

Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Further copies of this mark scheme are available from aqa.org.uk

Question	Part	Marking Guidance			
1	**(a)**		Draw the symbol for an NPN Transistor **and** label the legs.  Correct Symbol 1 mark All 3 labels correct 1 mark	**2**	
1	**(b)**		Give **two** properties of copper that make it a suitable material for the production of thin electrical wires. Property 1 - Conductivity (1) or Ductility (1) or Flexibility (1) or Can be soldered (1) or ETC. Property 2 - Conductivity (1) or Ductility (1) or Flexibility (1) or Can be soldered (1) or ETC.	**2**	

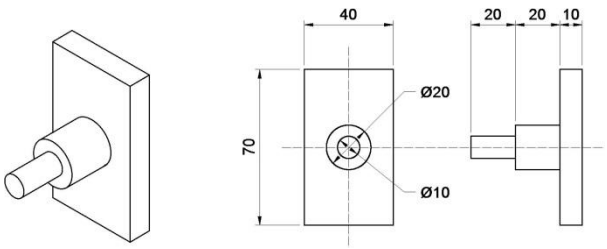
2	**(a)**		Explain the following terms: (a) electrical resistance Opposes - restricts - reduces – limits – Etc (1) the flow of Current (1) **or** Resistance = Voltage / Current (1)	**2**	
2	**(b)**		(b) friction Force resisting movement (1) Reaction to **or** opposes the moving force thus resisting the movement (2)	**2**	

3			Describe a system that would have a clockwise rotary input of 300 rpm and produce an output of 5 rpm counter-clockwise. Use annotated sketches to support your answer. Input and Outputs referenced and rotating in opposite directions 1 mark Suitable system to invert rotation and transmit motion 1 mark System reduces speed of rotation 1 mark System produces 60:1 reduction 1 mark	**4**	

4	**(a)**		Complete the truth table for the circuit shown below. A B C Q **0 0 0 0** **0 0 1 0** **0 1 0 1** **0 1 1 0** **1 0 0 1** **1 0 1 0** **1 1 0 1** **1 1 1 0** Every pair of correct output lines 1 mark (4 possible pairs) 4 x 1 mark **Or** complete inversion of Q column 2 marks	**4**	

4	**(b)**		Describe in detail how to test a silicon diode to make sure it is functioning correctly. Use sketches to support your answer. Suitable sketch assisting explanation and showing test equipment eg multimeter or bulb and battery 1 mark Reference to testing for current flow in both directions 1 mark Reference to expected results 1 mark Reference to minimum voltage for junction to operate (could be referenced by a suitable battery voltage **or** use of a multi-meter) 1 mark	**4**	

5	**(a)**		Describe a system that will flash a 12 volt light bulb at a starting frequency of 1 Hz that increases by 1 Hz every 10 seconds. Use annotated sketches to support your answer. Suitable sketch that assists explanation 1 mark Device shown that will produce on/off 1 mark Output capable of driving 12 volt bulb 1 mark Power supply correctly connected 1 mark Explanation of how 1 Hz produced Basic (1) Values but incorrect (2) Correct values (3) 3 marks Explanation of how 1 Hz is increased Basic (1) with 10 sec timing (2) and 1 Hz increase (3) 3 marks	**10**	

5	**(b)**		Describe in detail how the artefact shown in **Figure 1** could be produced accurately ($\pm$ 0.1mm) from a metal of your choice. Use annotated sketches to support your answer. Your answer should make reference to: • how the required level of accuracy is achieved • the stages in the production process • the processes, tools and equipment used.  Solution could be fabricated – cast – die cast – sintered etc. If not fabricated the answer must involve reference to the mould or pattern production along with the artefacts production.	**10**	

			Example – Fabrication Suitable material identified 1 mark Appropriate material blank(s) with dimensions 1 mark Process/tools for determining spigot position 1 mark Process/tools for producing spigots 1 mark Process/tools for producing backplate 1 mark Process/tools for positioning spigot 1 mark Process/tools Joining of parts Basic (1) Fully explained (2) 2 marks Tools and equipment capable of working to level of accuracy required – Backplate 1 mark Spigots 1 mark		

6	**(a)**		Show a system that will only illuminate a light when four switches are operated in the sequence: Switch 1 Switch 2 Switch 4 Switch 3. If any switch is operated out of sequence an alarm should sound and remain on until a separate reset switch is operated. Use annotated sketches to support your answer. Suitable sketch that assists explanation – Includes Power supply/ 4 switches and light 1 mark Sequence 1 – 2 (1) with Explanation (2) Sequence 1 -2 - 4 (2) with Explanation (3) Sequence 1 -2 - 4 – 3 (3) with Explanation (4) 4 marks Detection of incorrect sequence – At start only (1) At more than one point in sequence (2) At any point in sequence (3) 3 marks Latching function of alarm 1 mark Reset that unlatches 1 mark	**10**	

6	**(b)**		Describe a system that will take 10 seconds to complete one cycle of reciprocating motion. The amount of linear movement should be variable between 50 mm and 200 mm. Use annotated sketches to support your answer. Suitable sketch that assists explanation – Indicating input and Prime mover 1 mark Indicating output 1 mark System capable of producing reciprocating motion 1 mark Parts supported / guided 1 mark	**10**	

			Timing of cycle explained (1) set at 10 seconds (2) 2 marks Linear motion variable (1) With explanation (2) 2 marks Minimum correct at 50mm 1 mark Maximum correct at 200mm 1 mark		

7	**(a)**	**(i)**	A system is required to control the flow of traffic automatically where a railway line crosses a road (a level crossing). Show a system for sensing when a train is approaching **and** show the output it produces when a train is detected. Suitable sensor for detecting a train 1 mark Sensor mounted in a suitable position 1 mark Explanation of how train activates system 1 mark Explanation of how output is produced 1 mark	**4**	

7	**(a)**	**(ii)**	Show how the output from **7 (a) (i)** could be communicated to the level crossing which will be a long distance away. Use a diagram to support your answer. Suitable transmission system 1 mark Suitable receiving system 1 mark	**2**	
7	**(b)**	**(i)**	Describe a system that will switch on a 240 volt lamp automatically when it receives an input. The lamp should remain on until a reset is operated. Use an annotated sketch to support your answer. Suitable sketch to aid explanation that includes main parts 1 mark Suitable latching system 1 mark Reset for latch 1 mark Output capable of activating 240v lamp 1 mark Fully functioning system with explanation 1 mark	**5**	

7	**(b)**	**(ii)**	Describe a system that will automatically flash two 240 volt lamps alternately when activated by an input. Use an annotated sketch to support your answer. Suitable sketch to aid explanation that includes main parts 1 mark Suitable astable system 1 mark System activated by an input 1 mark Output capable of activating two 240v lamp 1 mark Fully functioning system with explanation 1 mark	**5**	

7	**(b)**	**(iii)**	Give a reason why an audible warning device and a physical barrier might also be necessary at a level crossing. Reason (1) with clarification (2) Audible Warning - To get the attention of motorist who is looking at something else OR for pedestrians who will not necessarily look at the lights – etc. Physical Barrier - eg. To stop motorists going through a red light – etc.	**4**	**2 x 2 marks**

7	**(c)**		Produce a design for a complete automatic level crossing system that fulfils the following requirements: • sense when a train is approaching **and** illuminate an amber light to warn motorists • after 5 seconds two red lights flash alternately at 1 Hz to stop the motorists • after 10 seconds a barrier closes to block the road • when the train is fully clear of the level crossing	**20**	

			the barrier should open • when the barrier is fully open all the lights should go off. Your diagrams should clearly show where **and** how the various parts of the system are positioned and mounted with the control and interaction between the sub-systems explained. Marks will be awarded for: • the system that senses the approaching train Positioning of two sensors (1) Provision of inputs to main control (1) **[2 marks]** • the control system Inputs from sensors clearly shown and suitable (1) Time delay system for amber (1) Time delay system for Flashing Red and barrier close (1) Latching system (1) Reset system (1) Switching off all lights and opening barrier (1) **[6 marks]** • barrier and drive systems Sketch of barrier capable of opening/closing (1) Prime mover with reversing system (1) Drive system from prime mover to barrier (1) Limitation of barrier movement (1) **[4 marks]** • assembly and integration of the sub-systems Inputs interfaced to control (1) Lights interfaced to control (1) Barrier interfaced to control (1) Complete system (1) **[4 marks]** • selection of materials, components and mountings. Majority of materials identified and suitable for environment (1) All lights suitably mounted (1) Barrier components mounted and suitable (1) Majority of control components identified and suitable (1) **[4 marks]**		