New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2010

Technology and Design

Assessment Unit AS 1

assessing

Product Design and
Systems and Control

[AV111]

AV111

WEDNESDAY 20 JANUARY, MORNING

TIME

2 hours.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the Answer Booklet provided and on the A3 pro forma answer page provided.
Answer **all eight** questions in Section A, and both questions in **either** Section B **or** Section C.
An A3 pro forma is provided for Questions **12(b), (c) and (d)**.
At the conclusion of the examination, attach the A3 pro forma answer page securely to the Answer Booklet with the treasury tag supplied.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80, including a maximum of 4 marks for quality of written communication.
Marks for quality of written communication (QWC) will be awarded for Questions **7(i), 8, 10(b)(i) and (ii)** and **11(e)(i) and (ii)**.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
All questions do not carry equal weighting.

Section A

Product Design and Practice

Answer **ALL** questions in this section.

You are advised to spend approximately **1 hour** on this section.

1 Explain what is meant by the following properties:
- Electrical conductivity
- Thermal conductivity
- Durability
- Brittleness [4]

2 Metals are supplied and used in a range of forms.

(i) State **four** different forms in which metal is available. [2]

(ii) Drill bits can be manufactured from high carbon steel. Give **two** main reasons why high carbon steel is used. [2]

3 Garden hose pipes are manufactured by the process of extrusion.

(i) State **two** main reasons why extrusion is the most suitable process for the manufacture of this product. [2]

(ii) Suggest a suitable material for the extrusion of garden hose pipes. [1]

(iii) With the aid of an annotated sketch describe the extrusion process. [3]

4 **(i)** Briefly explain the difference between a composite and an alloy. [2]

(ii) Shape memory alloy and piezoelectric materials are considered smart materials.

Briefly explain **one** main characteristic for shape memory alloy and **one** main characteristic for piezoelectric materials and give **one** specific application for each. [4]

5 **(i)** Distinguish between permanent and semi-permanent methods used in the joining of materials. [2]

(ii) Brazing and welding are widely used methods in the joining of metals.

Briefly outline **two** main characteristics for each of the methods above. [4]

6 The Trades Description Act and British Standards are important to manufacturing companies.

(i) Briefly outline **two** main characteristics associated with the Trades Description Act. [2]

(ii) Briefly outline **two** main characteristics associated with British Standards. [2]

7 Materials such as steel are produced through continuous production.

(i) Outline **three** main characteristics associated with continuous production. [3]

QWC [1]

(ii) State **one** example of a material, other than steel that would be produced through continuous production. [1]

8 Cultural and social changes can have an influence on the design of products. With reference to the car, outline **one** main cultural change and **one** main social change and explain how these changes have influenced the design of the car. [4]

QWC [1]

Answer the questions in **Section B** or **Section C**.

Section B

Electronic and Microelectronic Control Systems

Answer **both** questions in this section.

You are advised to spend approximately **1 hour** on this section.

9 **Fig. 9(a)** shows a logic circuit which uses switches as inputs and has an LED output.

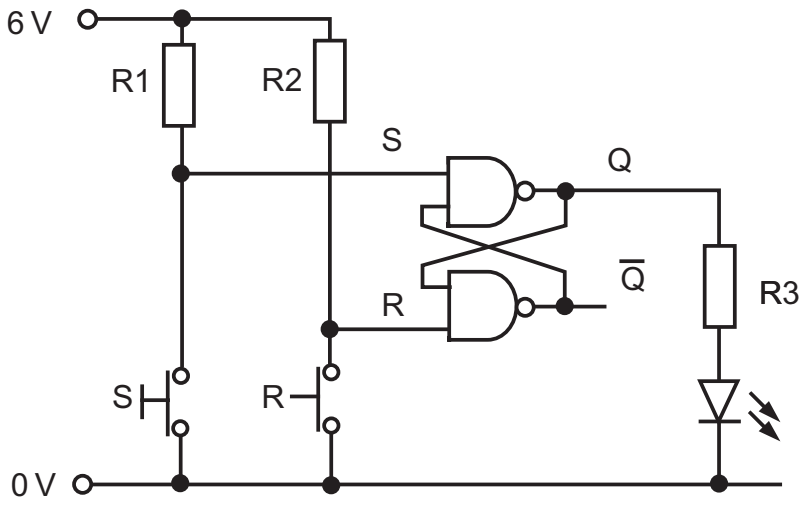


Fig. 9(a)

(a) **(i)** Name the type of logic gate used in the circuit shown in **Fig. 9(a)**. [1]

(ii) Name the arrangement of gates shown in **Fig. 9(a)**. [1]

(iii) Briefly explain the function of the resistors R1 and R2 in the circuit shown in **Fig. 9(a)**. [2]

(iv) Draw a truth table for the circuit shown in **Fig. 9(a)** for the inputs S and R and the outputs Q and $\overline{Q}$. [5]

(b) The LED in **Fig. 9(a)** is designed to work at a forward voltage of 1.8 volts and a current of 15 mA.

(i) Calculate the value of resistor R3 in **Fig. 9(a)** required to allow the LED to function safely. Assume that the output voltage corresponding to a logic high is 6 volts. [2]

(ii) Choose a value for the resistor from the E12 preferred value series as shown below.

10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82 [1]

(iii) Calculate the power dissipated by your preferred value resistor and then select the most appropriate rating from the range available. Resistors are available in 0.25, 0.5 and 0.75 watt ratings. [3]

(c) The circuit shown in **Fig. 9(a)** is to be modified to switch on a high voltage motor using a transistor and relay based circuit.
Using an annotated circuit diagram show how this modification could be achieved. [4]

10 A circuit with a variable resistor and a thermistor is shown in **Fig.10(a)**.

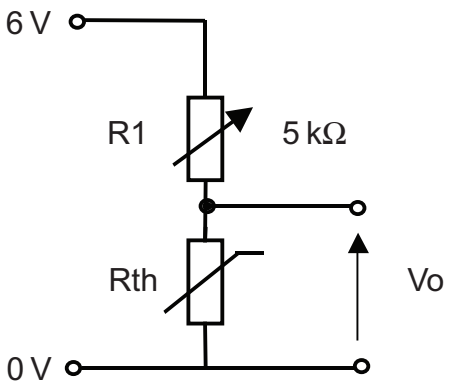


Fig. 10(a)

(a) The thermistor shown in **Fig. 10(a)** has a negative temperature coefficient.

(i) Explain what is meant by the term negative temperature coefficient. [1]

(ii) Draw a graph to show how the voltage Vo varies with temperature. [3]

(iii) Calculate Vo in **Fig. 10(a)** when the resistance of the variable resistor is 5 kΩ and the resistance of the thermistor is 2.2 kΩ. [2]

(b) A 555 integrated circuit is connected to other components, including a variable resistor as shown in **Fig. 10(b)**.

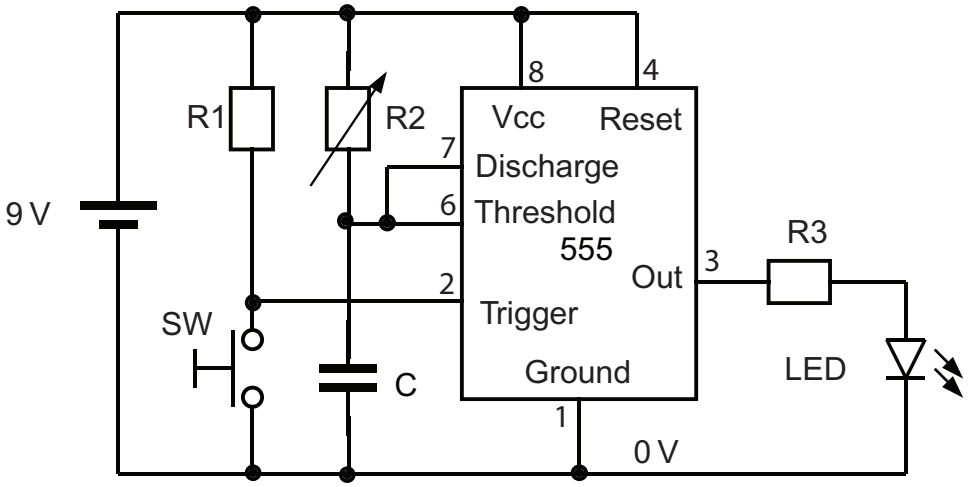


Fig. 10(b)

(i) State if the circuit shown in **Fig. 10(b)** is an example of an open loop or closed loop system and briefly justify your choice. [2]

QWC [1]

(ii) Describe the operation of the circuit shown in **Fig. 10(b)** making reference to the components that control the timing. [4]

QWC [1]

(iii) Calculate the range of the variable resistor R2 to illuminate the LED in **Fig. 10(b)** for the periods ranging from 1 second to 5 seconds when C = 100 µF given that the Time Period T = 1.1 × C × R2 seconds. [4]

(c) A programmable system such as a PIC could be employed to achieve the same function as the hard-wired circuit shown in **Fig. 10(b)**.
List **two** advantages and **one** disadvantage of using a programmable system over a hard-wired system. [3]

Section C

Mechanical and Pneumatic Control Systems

Answer **both** questions in this section.

You are advised to spend approximately **1 hour** on this section.

11 **Fig. 11** shows a mechanical system incorporating a motor, pulley and gears.

(a) **(i)** Name a belt type which can be used on pulleys which are at 90 degree angles to each other. [1]

(ii) State the direction of rotation at **G** if **A** rotates in an anticlockwise direction. [1]

(b) **(i)** Calculate the overall velocity ratio between **A** and **K**. [2]

(ii) Calculate the overall velocity ratio between **A** and **I**. [3]

(iii) Calculate the difference in output speeds between **D** and **K** if the motor rotates at 240 rev/min. [3]

(c) **(i)** Pulley **A** is attached to the motor shaft using a key and keyway. Using an annotated sketch outline the main features of this arrangement. [2]

(ii) Name **one** other method of attaching pulleys to shafts apart from a key and keyway or grub screw. [1]

(d) Occasionally the heavy motor needs to be raised and lowered from the ground to aid pulley belt replacement. Using an annotated sketch name and draw a linkage system which could keep the motor base level with the ground. [3]

(e) The mechanical system is to be attached to a cam and follower. Describe the following terms:

(i) Dwell. [1]

QWC [1]

(ii) Stroke length. [1]

QWC [1]

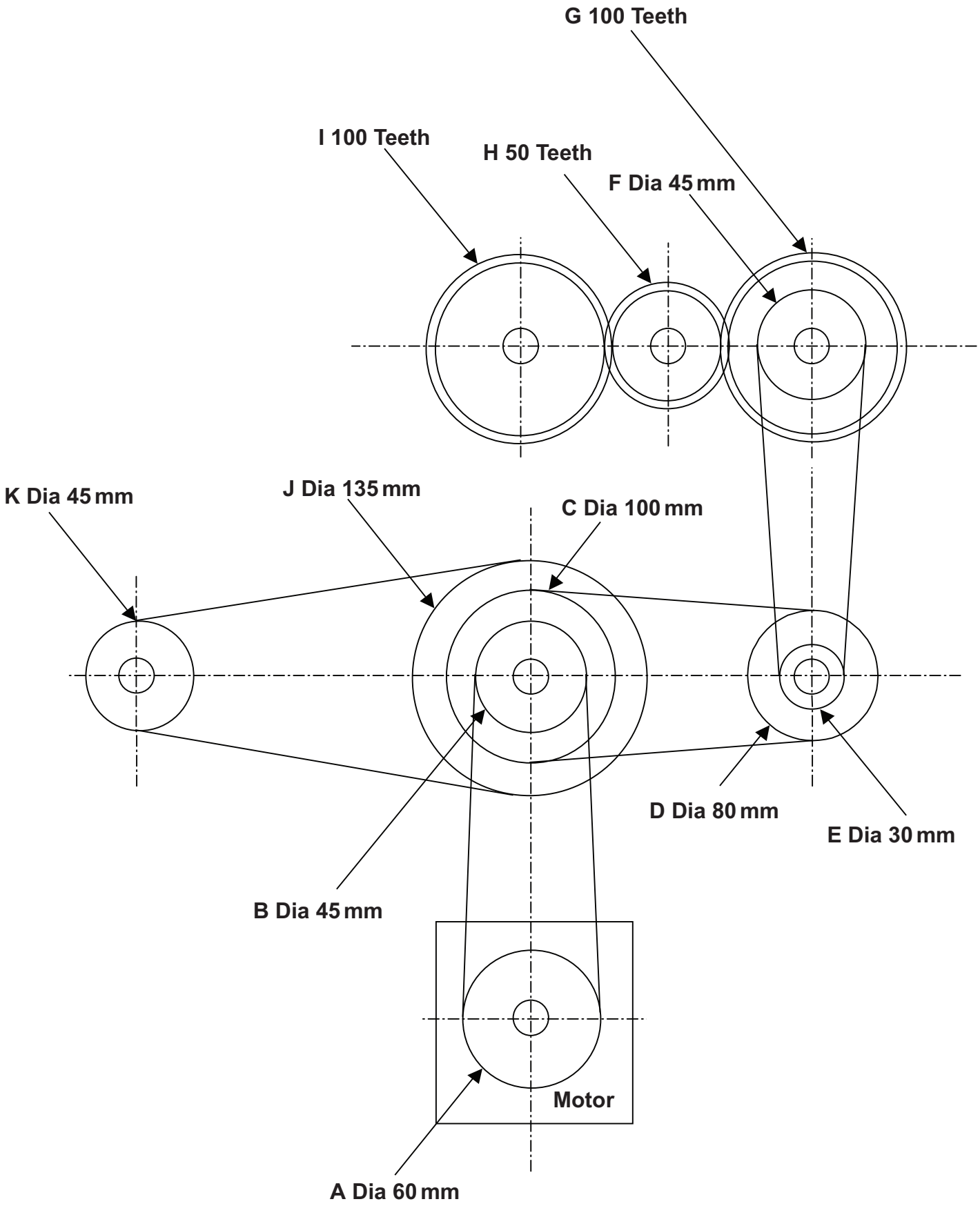


Fig. 11

12 **Fig. 12** shows part of an incomplete pneumatic system incorporating a single and double acting cylinder.

(a) **(i)** Name the activation method at valve **A**. [1]

(ii) Name the activation method at valve **C**. [1]

(iii) Name the activation method at valve **X**. [1]

(iv) Draw an airbleed showing how it is used to activate a single three port valve. [2]

(b) On the pro forma provided **(answer number 12(b)**, **(c) and (d))** complete the circuit enabling the double acting cylinder to outstroke if 3 port valves **A and B and C or D** are activated. [4]

(c) On the pro forma provided **(answer number 12(b)**, **(c) and (d))** complete the circuit enabling the single acting cylinder to outstroke slowly as the double acting cylinder instrokes. [3]

(d) On the pro forma provided **(answer number 12(b)**, **(c) and (d))** complete the circuit enabling the double acting cylinder to instroke after a delay in time following an outstroke. [4]

(e) The double acting cylinder is supplied with an air pressure of 0.5 N/mm^2 and produces a force during the outstroke of 235.12 N and 210 N during the instroke. Calculate the piston rod diameter. Please assume π = 3.14. [4]

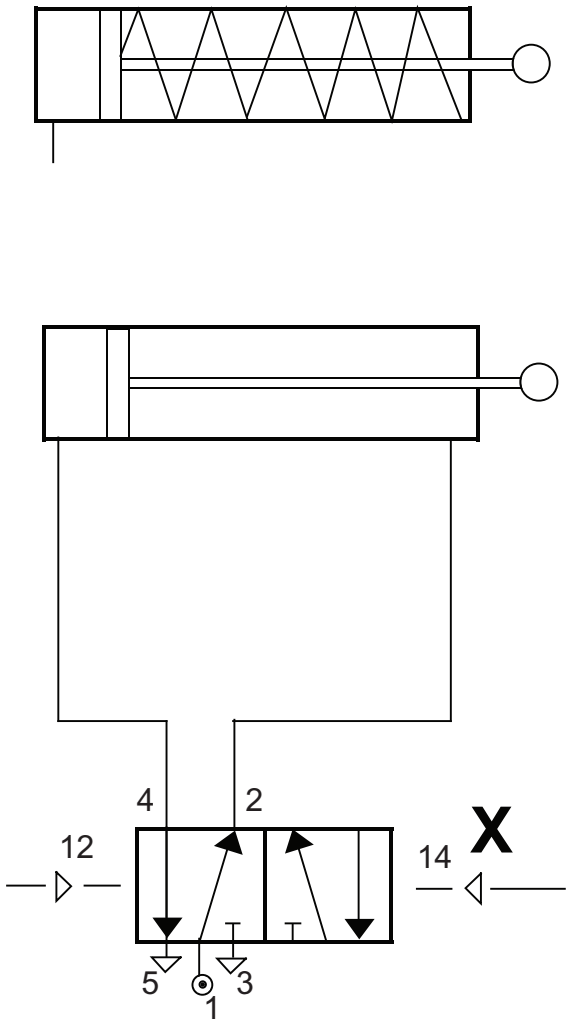


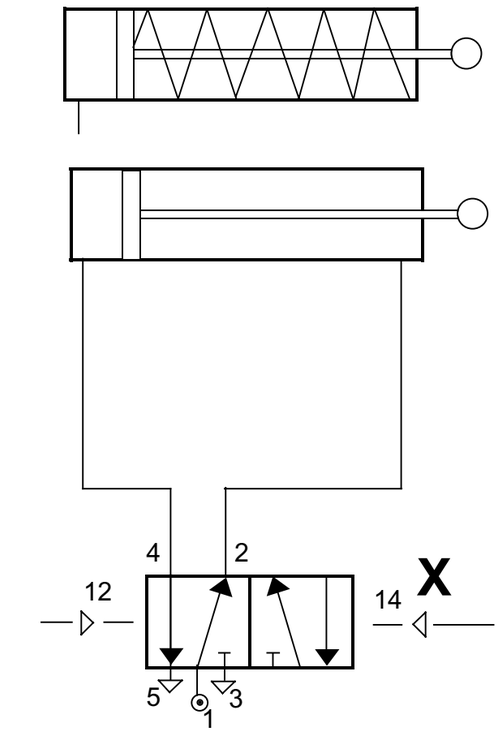
Fig. 12

Question No. 12(b), (c) and (d)

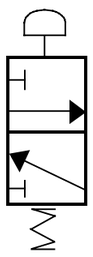
ADVANCED SUBSIDIARY (AS) TECHNOLOGY AND DESIGN
Assessment Unit AS 1 Unit 1
January 2010

Centre Number: 71

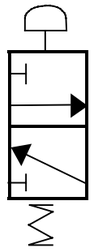
Candidate Number:



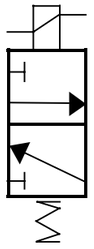
B



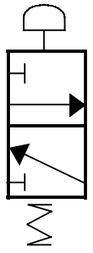
A



C



D



Pro forma answer page
(answer numbers 12(b), (c) and (d))

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