



Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
January 2009

Technology and Design

Assessment Unit AS 1

assessing

Product Design and
Systems and Control

[AV111]



THURSDAY 8 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 Question **12(a)(iv)** and **(v)**.

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 will be awarded for questions **4**, **6(ii)**, **9(b)(ii)**, **10(b)(iv)**, **11(a)(v)** and **12(a)(iii)**.

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 When selecting a metal for external gates, railings and stairs, the designer needs to consider the following:

- Functional requirements
- Manufacturing demands
- Environment
- Availability

For each of the four points above, briefly outline the information the designer would gain from each. [4]

2 Products manufactured from metals use a range of finishes.

(i) Briefly explain the difference between ferrous and non ferrous metals. [1]

(ii) Briefly explain the processes of plastic coating and electroplating. [4]

3 Litter bins, storage tanks and traffic bollards are manufactured by the process of rotational moulding.

(i) State **one** main reason why rotational moulding is the most suitable process for the manufacture of these products. [1]

(ii) Suggest a suitable material for the rotational moulding process. [1]

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

4 Manufacturing systems can be organised through cell production, flexible manufacturing systems (FMS), just-in-time (JIT) and concurrent engineering.

For any **three** of the above systems, outline **two** main characteristics of each. [7]

- 5 Plywood, blockboard, medium density fibreboard (MDF) and chipboard offer many advantages and are suitable for a wide range of uses.
- (i) State **one** main advantage plywood has compared to blockboard. [1]
 - (ii) State **one** advantage MDF has compared to chipboard. [1]
 - (iii) State **one** specific application for plywood and **one** specific application for MDF. [2]
- 6 For a design and manufacturing company, testing, inspecting and quality systems are established procedures.
- (i) Give **two** main reasons why it is so important for a company to test and inspect its products. [2]
 - (ii) Explain what is meant by Quality Assurance (QA) and Quality Control (QC) systems. [5]
- 7 Ergonomics are important when designing products such as the mobile phone.
- (i) Briefly explain what is meant by the term ergonomics. [1]
 - (ii) Identify and explain **three** aspects of the mobile phone which show that the designer has considered ergonomics. [3]
- 8 The environmental influences of sustainability and life cycle analysis are factors that may be considered by product designers.
- (i) Briefly explain what is meant by sustainability and life cycle analysis in relation to our environment. [2]
 - (ii) Select a suitable product and briefly explain how the designer has considered sustainability. [2]

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 (a) An arrangement of three logic gates is shown in **Fig. 9(a)**.

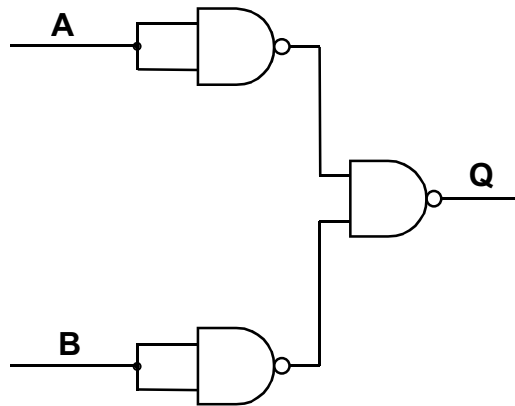


Fig. 9(a)

- (i) Name the type of logic gate used in **Fig. 9(a)**. [1]
- (ii) Draw a truth table for all input combinations of **A** and **B** and the corresponding output **Q** for the arrangement of logic gates shown in **Fig. 9(a)**. [3]
- (iii) State **one** logic gate that could be used to replace all three logic gates shown in **Fig. 9(a)**. [1]
- (iv) Using a circuit diagram, show how push to make switches with pull down resistors could be used as inputs to the logic circuit shown in **Fig. 9(a)**. [3]

- (b) The output from a 5 V logic circuit is to be used to switch on a 12 V motor using a transistor based driving circuit. Part of the driving circuit is shown in **Fig. 9(b)**.

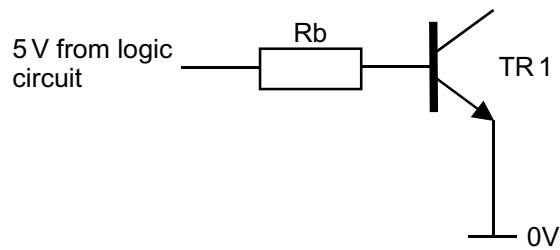


Fig. 9(b)

- (i) Draw a circuit diagram to show how a 12 V motor would be controlled by the transistor shown in **Fig. 9(b)**. Assume the transistor uses a 9 V power supply. [2]
- (ii) Explain how the circuit that you have drawn for (b)(i) is used to control the motor, making reference to any additional components used. [5]
- (iii) The transistor shown in **Fig. 9(b)** has a current gain (h_{FE}) of 60 and a base/emitter voltage (V_{be}) of 0.7 V. If the collector current is to be limited to 420 mA, calculate the required value of resistor R_b . [3]

10 (a) Part of a time delay circuit is shown in Fig. 10(a).

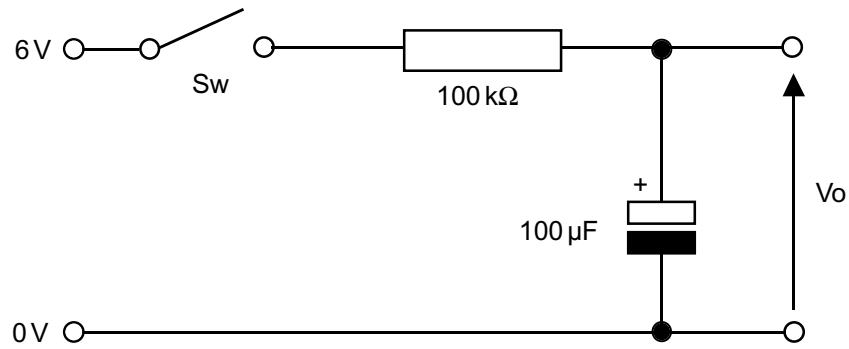


Fig. 10(a)

- (i) Calculate the time constant for the circuit shown in Fig. 10(a). [1]
- (ii) Sketch and label a graph showing the voltage V_o against time as the capacitor in Fig. 10(a) is being charged and clearly indicate the time constant on the graph. [3]
- (iii) Explain with the aid of a circuit diagram how the capacitor could be rapidly and safely discharged after the switch Sw is opened. [3]

(b) A circuit based on a 555 timer is shown in Fig. 10(b).

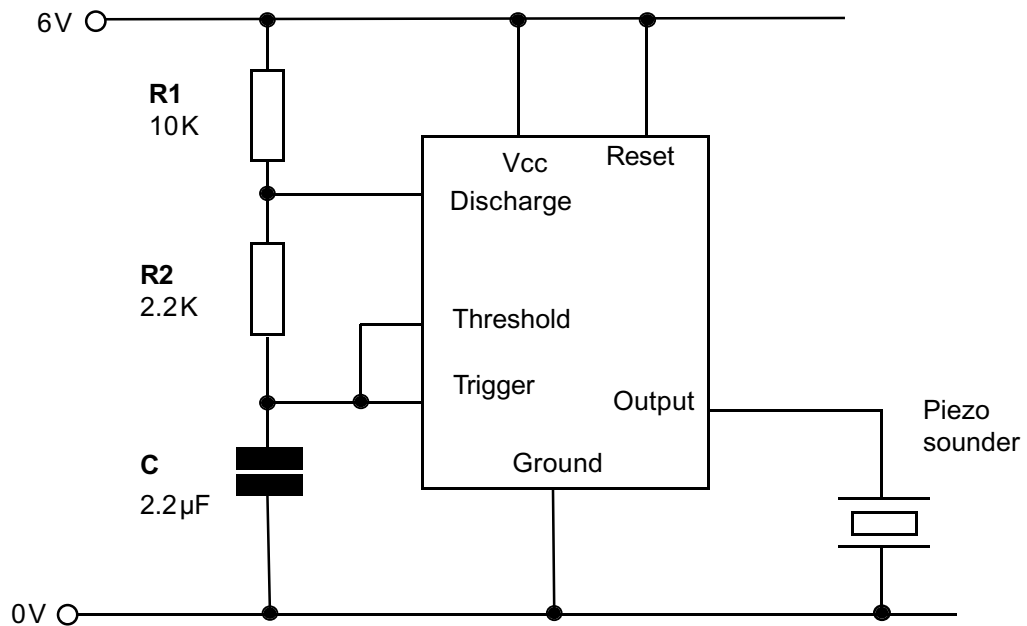


Fig. 10(b)

- (i) State whether the circuit shown in Fig. 10(b) is an open loop or closed loop system and justify your answer. [2]
- (ii) Calculate the output frequency of the circuit shown in Fig. 10(b) given that $T = C(R1 + 2R2)/1.44$. [3]
- (iii) Explain the operation of the circuit shown in Fig. 10(b). [6]
- (iv) The circuit in Fig. 10(b) is to be modified to enable a number of different output frequencies to be selected by operating a switch. Explain with the aid of a circuit diagram how this could be achieved and state a suitable type of switch. [4]

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 various components assembled to form a prototype drive system.

- (a) (i) State the direction of rotation at shaft **Z** if gear **C** rotates in a clockwise direction. [1]
- (ii) Calculate the overall velocity ratio from shaft **X** to shaft **Z**. [2]
- (iii) Calculate the speed of the wormwheel if the motor rotates at 240 rev/min. [3]
- (iv) Calculate the speed of shaft **Z** if the wormwheel rotates at 2 rev/min. [4]
- (v) The tension on the belt connecting pulleys **M** and **N** must be kept at a suitable level to avoid slipping. Using an annotated sketch, describe a method to keep the belt at the correct tension. [3]
- (vi) Using an annotated sketch, show how gear **A** could be attached to shaft **X** using a grub screw. [3]
- (b) If required, a crank and slider mechanism could be added to the system to produce a reciprocating output. State **one** other method used to convert rotary motion to reciprocating. [1]
- (c) The various components shown in **Fig. 11** are re-assembled to form a different drive system. This system operates with an overall efficiency of 87.5% and has a velocity ratio of 8. Calculate the mechanical advantage. [3]

12 Fig. 12(a) opposite shows part of an incomplete pneumatic circuit.

- (a) (i) Name the activation method of the 3PV Y. [1]
- (ii) State the purpose of the symbol shown on port 3 on the five port valve. [1]
- (iii) The compressed air supplied to these components has been prepared for use. Describe the function of filter and lubrication units. [3]
- (iv) On the pro forma provided (Answer No 12(a)(iv)+(v)), complete the circuit to enable the double acting cylinder to instroke once the PTM Switch has been activated. [3]
- (v) On the pro forma provided (Answer No 12(a)(iv)+(v)), complete the circuit to enable the double acting cylinder to outstroke once X and Y and Z have been activated. Please note that X is activated using an airbleed. [5]

(b) If required, a time delay circuit as shown in Fig. 12(b) could be added to the circuit as a modification. Describe the operation of a time delay circuit. [4]

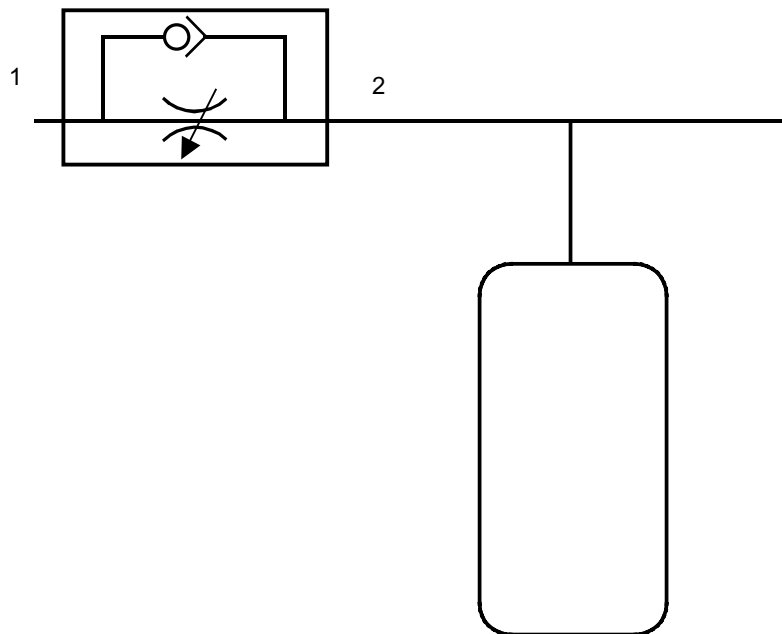


Fig. 12(b)

(c) A double acting cylinder produces a positive force during the outstroke of 212 N using an air pressure of 0.4 N/mm². Showing all calculations, state the piston diameter.

Please assume $\pi = 3.14$. [3]

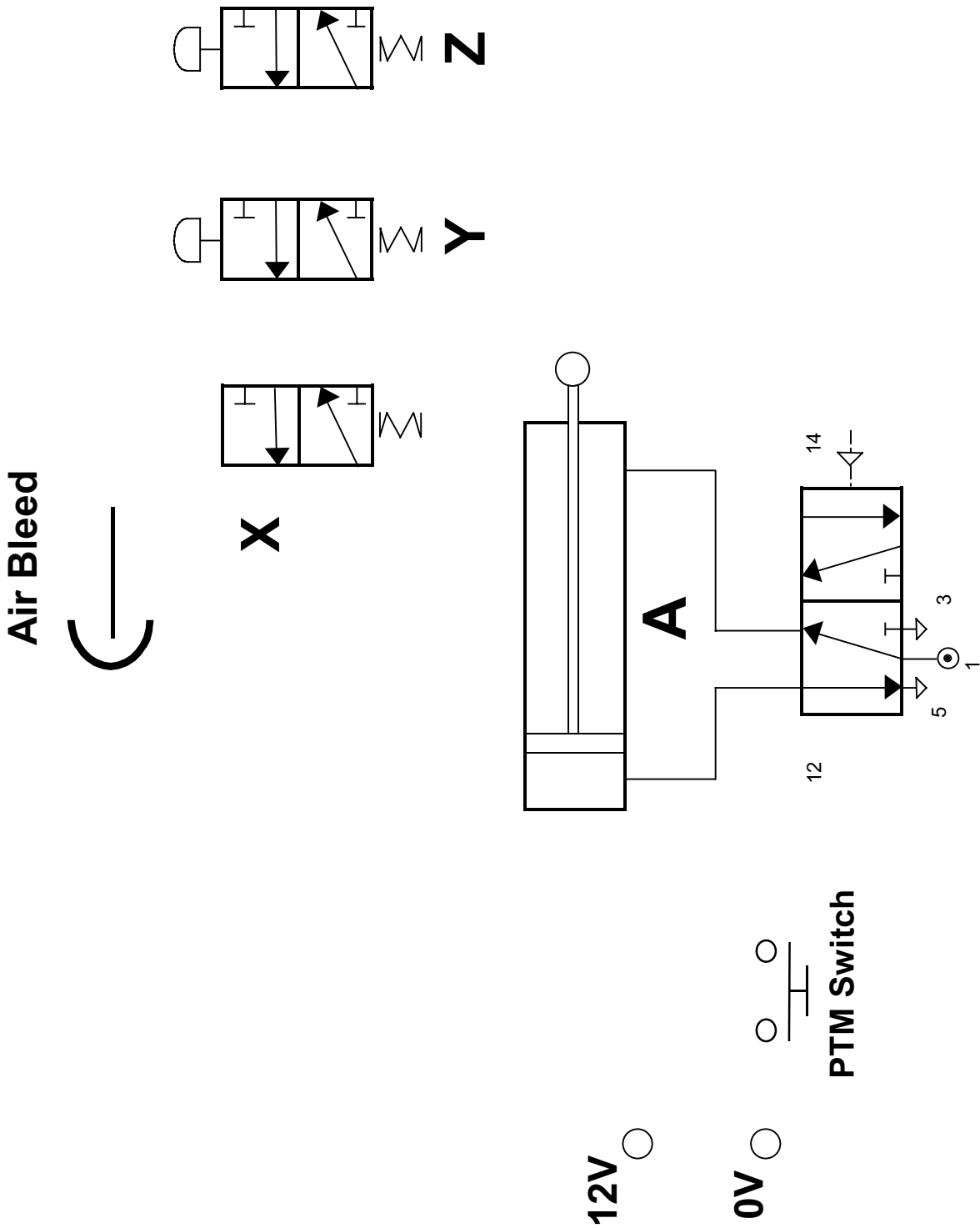


Fig. 12(a)

