

Specimen Papers and Mark Schemes for
Technology and Design: Systems and Control

For first AS Examination in 2009
For first A2 Examination in 2010

Subject Code: 9060

tech
nology
and
design

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Specimen Papers

Centre Number

71



Candidate Number

**ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009**

Technology and Design

Assessment Unit AS 1

assessing

Production Design and Systems and Control

SPECIMEN PAPER

TIME

2 hours

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the answer booklet provided.
Answer **all eight** questions in Section A and both questions in either Section B or Section C.

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 5, 6, and 8(ii).
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

At the conclusion of the examination, attach the A3 pro forma answer pages securely to the Answer Booklet with the treasury tag supplied.

Section A

Answer **ALL** questions in this section

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

- 1** When selecting a material the property of strength can have a considerable influence.
- (i)** Identify and briefly explain the difference between the four elements of strength. [2]
 - (ii)** Select any two elements identified in part (i) then state **one** specific metal for each which best illustrates its characteristics. [2]
- 2** Snap-on casings for mobile phones are manufactured by a process of injection moulding.
- (i)** Give **two** main reasons why injection moulding is the most suitable process for this product. [2]
 - (ii)** Suggest a suitable material for the injection moulding process. [1]
 - (iii)** With the aid of an annotated sketch describe the injection moulding process. [2]
- 3** Manufacturers of kitchen and bedroom units use chipboard melamine, plywood and medium density fibreboard (MDF).
- (i)** Briefly distinguish between chipboard melamine, plywood and MDF. [3]
 - (ii)** State **two** main properties of chipboard melamine that makes it suitable for kitchen worktops. [1]
- 4** In an attempt to generate ideas the designer can use a range of creativity techniques.
- (i)** Identify **two** creativity techniques commonly used by designers. [1]
 - (ii)** Briefly outline **two** main characteristics for each of the **two** creativity techniques identified in part (i). [4]
- 5** Culture and social changes can have an influence on the design of products. With reference to the car, briefly outline one main culture change and one main social change, and explain how these changes have influenced the design of the car. [5]

- 6 A company manufacturing injection moulded casings for games consoles have decided to investigate the use that Information and Communication Technology (ICT) can make.

For each of the following below briefly discuss how a company uses ICT for:

- Stock control
- Modelling
- CAD/CAM.

[8]

- 7 In the instructions leaflet for a self-assembly wardrobe, reference was made to the following terms:

- BSI for drawing
- Factor of safety
- Knockdown fitting
- Handles and hinges being standard components.

Briefly explain what is meant by these terms.

[4]

- 8 A potato crisp manufacturer in Northern Ireland is planning to install a fully automatic system, which will replace the eighty employees currently operating the packaging lines.

(i) Outline **one** negative and **one** positive aspect to the pattern of employment that would result if the plan was implemented.

[2]

(ii) Outline **two** economic considerations for the employer.

[3]

Section B

- 9 (a) An LED designed to work at a forward voltage of 2 volts at a current of 20mA is to be connected to a 12 volt supply is shown in **Fig 9 (a)**.

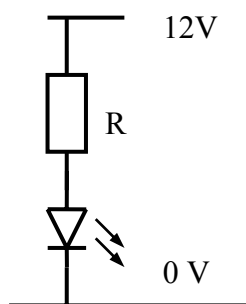


Fig 9 (a)

- (i) Calculate the value of resistance required to allow the LED to function safely. [2]
- (ii) Choose a practical value for the resistor from the E12 preferred value series 10, 12, 15, 18, 22, 27, 33, 39, 47, 56, 68, 82. [2]
- (iii) Calculate the power rating of the resistor and then select the most appropriate rating from those available. Resistors are available in 0.25, 0.5 and 0.75 watt rating. [2]
- (b) A 555 integrated circuit is connected as a monostable as shown in **Fig 9 (b)**.
- (i) Briefly describe the operation of the monostable. [4]
- (ii) The LED is to be illuminated (ON) for a period ranging from 0.2 seconds to 1.0 second. Calculate the range of variable resistance R_a when $C = 10 \mu\text{F}$ and given that the LED is illuminated for a period $T = 1.1 \times C \times R_a$ seconds. [4]
- (c) It is suggested that the monostable circuit in **Fig 9 (b)** could be used, as the basis of a circuit to check a person's reaction time is less than a certain value. Reaction time is the period between the observation of LED 'L' coming on and the pressing of a switch. If the person's reaction time is less than the period T of the output pulse then another LED is to be illuminated.



Fig 9 (b)

- (i) Suggest a logic gate that could be used to detect if a switch is pressed during the time LED 'L' is ON. [1]

- (ii) It is required to illuminate an LED after an output occurs from the logic gate in (b)(i). The LED remains illuminated until a reset switch is pressed. Show how an RS latch could be incorporated into the circuit to fulfil these requirements. [4]

- 10** A circuit for a simple burglar alarm is shown in **Fig 10 (a)** Switch A (which is in the closed position) is attached to a window and window frame.

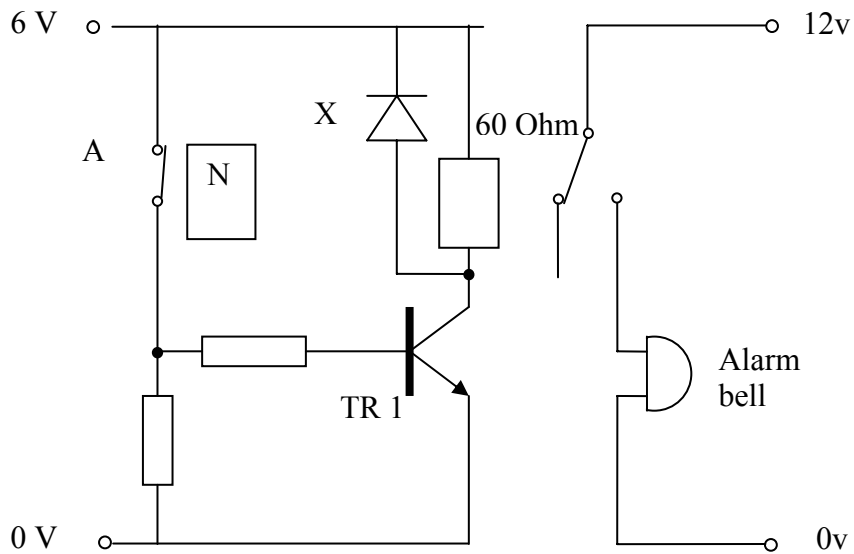


Fig 10 (b)

- (a)**
- (i)** Name the type of switch labelled A. [1]
 - (ii)** State the formula for the current gain (hFE) of a transistor. [1]
 - (iii)** Calculate the gain (hFE) of the transistor **TR 1** if the base current is 5mA and the resistance of the relay coil is 60 ohms. [2]
 - (iv)** Explain the operation of the circuit when the window is opened. [3]
 - (v)** State the purpose of component **X** in the circuit. [1]

- (b) To make the alarm in **Fig 10 (a)** more effective, a latching action is needed. This can be achieved by replacing the existing relay with a double pole double throw (DPDT) relay.

Draw the modification to the circuit in order to achieve this latching action. [4]

- (c) A student has designed a logic circuit using four logic gates as shown in **Fig 10 (b)**.

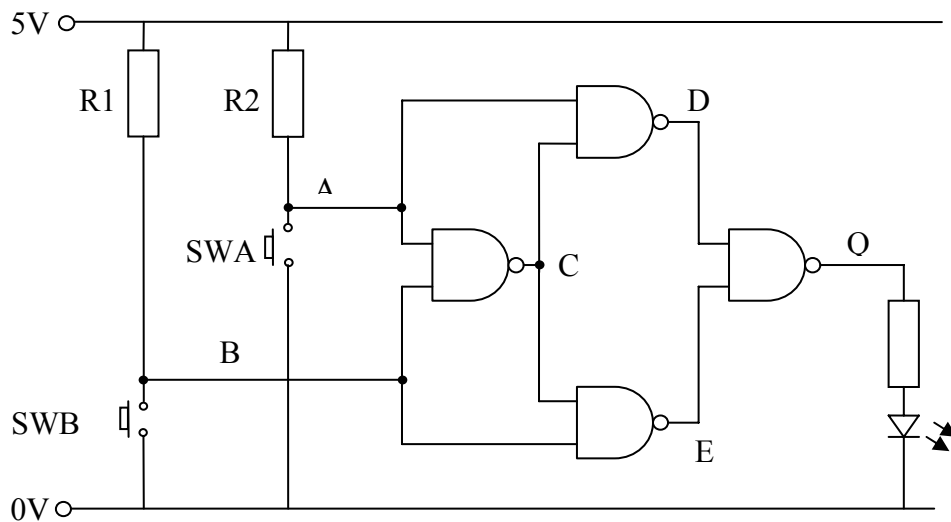


Fig 10 (b)

- (i) Studying the logic circuit in **Fig 10 (b)** then copy and complete the truth table (**Fig 10 (c)**) in your answer booklet.

A	B	C	D	E	Q

Fig 10 (c)

- (ii) State **one** logic gate type that could be used to replace all of the logic gates used in **Fig 10 (b)**. [1]
- (iii) Resistors **R1** and **R2** on **Fig 10 (b)** are ‘pull up’ resistors. Briefly explain what is meant by this term. [2]

An alternative circuit to that shown in **Fig 10 (b)** could make use of a programmable system such as a Peripheral Interface Controller (PIC) to achieve the same function.

- (iv) List 2 advantages and 2 disadvantages of using programmable systems over hard wired systems. (Make 4 distinctly different points – do not use the advantage of one as the disadvantage of the other.) [2]

Section C

- 11 Fig 11 (a)** shows various mechanical components assembled for testing.
- (a)** Name the mechanical component used at **A**. [1]
 - (b)** State the direction of rotation at **G** if the motor rotates clockwise. [1]
 - (c)**
 - (i)** Calculate the overall velocity ratio from mechanical component **A** to the output at **J**. [4]
 - (ii)** Calculate the speed at output **E** if the motor rotates at 480 rev/min. [5]
 - (iii)** An alternative component assembly to the one outlined in **Fig 11 (a)** has an efficiency of 87.5% and a mechanical advantage of 7. Showing all calculations determine the velocity ratio of the new assembly. [2]
 - (d)**
 - (i)** Pulley **J** is secured to the shaft using a grub screw. Using an annotated sketch draw this method of fixing to shafts. [3]
 - (ii)** Name one other method used to fix mechanical components to shafts. [1]
 - (e)** Name and sketch an alternative method of transferring rotary motion from shaft **Y** to shaft **X**. [3]

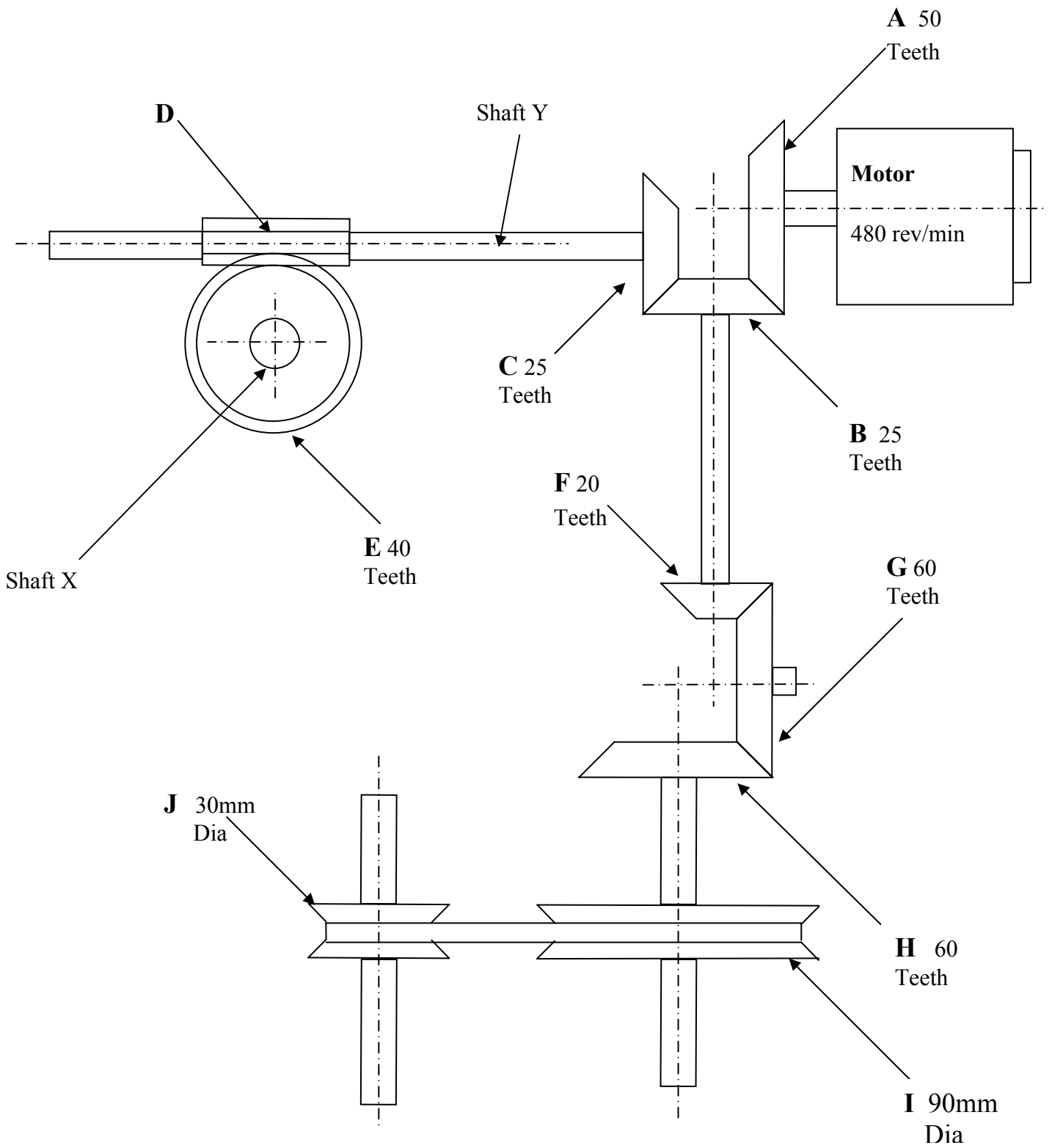


Fig 11 (a)

12 **Fig 12 (a)** shows an incomplete pneumatic circuit being developed as part of a school based assignment.

(a) Name the methods of operating the following three port valves:

(i) at A. [1]

(ii) at B. [1]

(b) What is the logic term given to the function of component **D**? [2]

(c) **(i)** On the pro forma provided (answer No 12 (b)) complete the circuit to enable the double acting cylinder to outstroke if either **A** or **B** is activated and **C**. [7]

(ii) Briefly describe what happens if the three port valves **A**, **B** and **C** are activated at the same time. [2]

(iii) On the pro forma provided (answer 12 (b)) complete the circuit to enable the double acting cylinder to instroke following a full outstroke. [4]

(d) **Fig 12 (c)** overleaf shows two components **R** and **S** added between the five port valve and the double acting cylinder to control the speed of the outstroke.

Briefly explain why this arrangement would fail to function properly. [3]

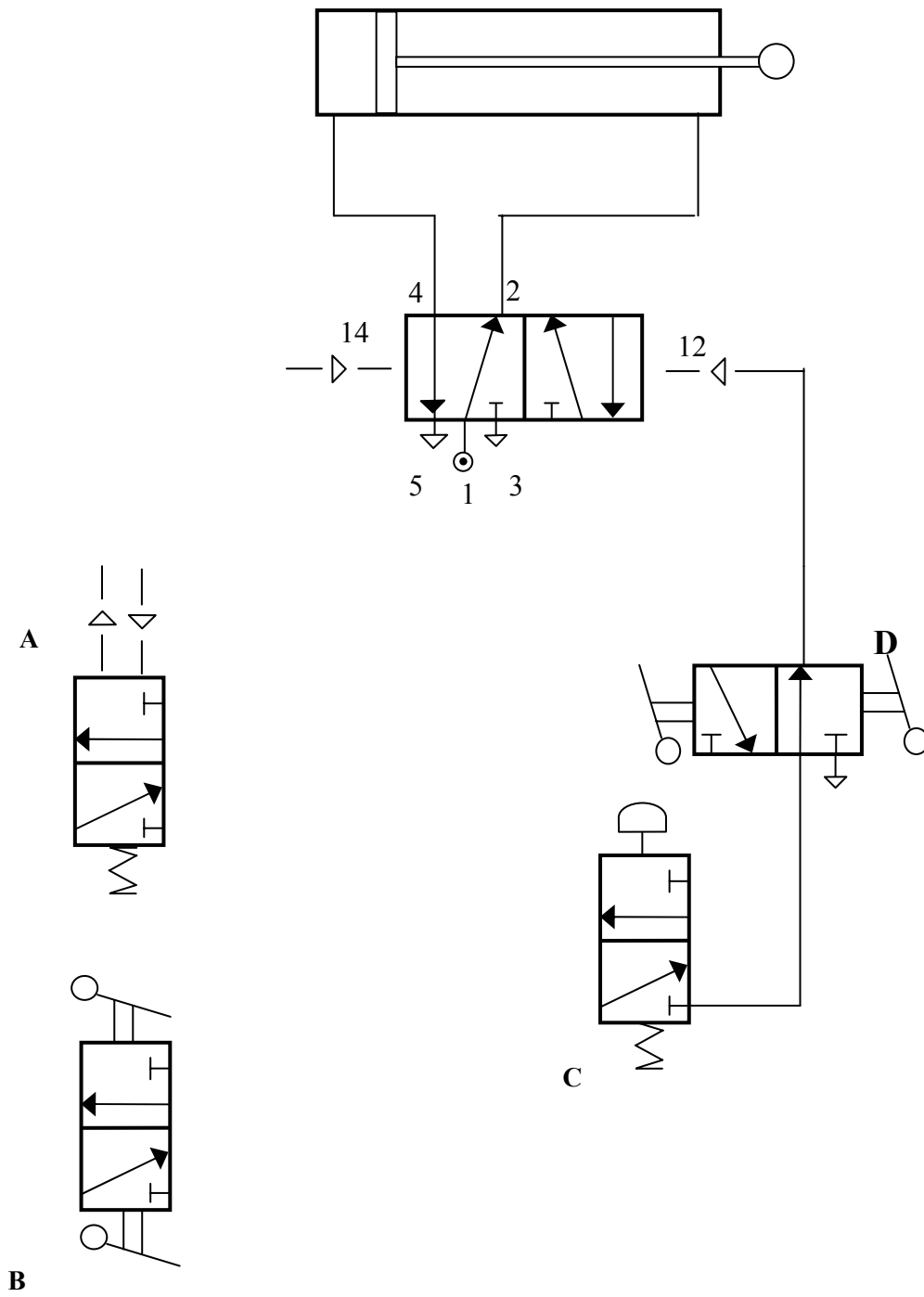
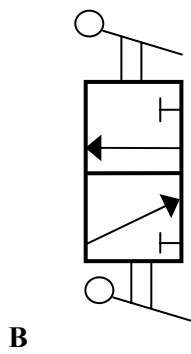
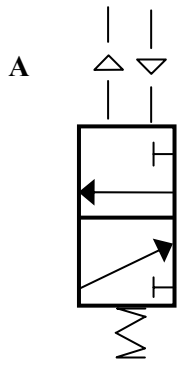
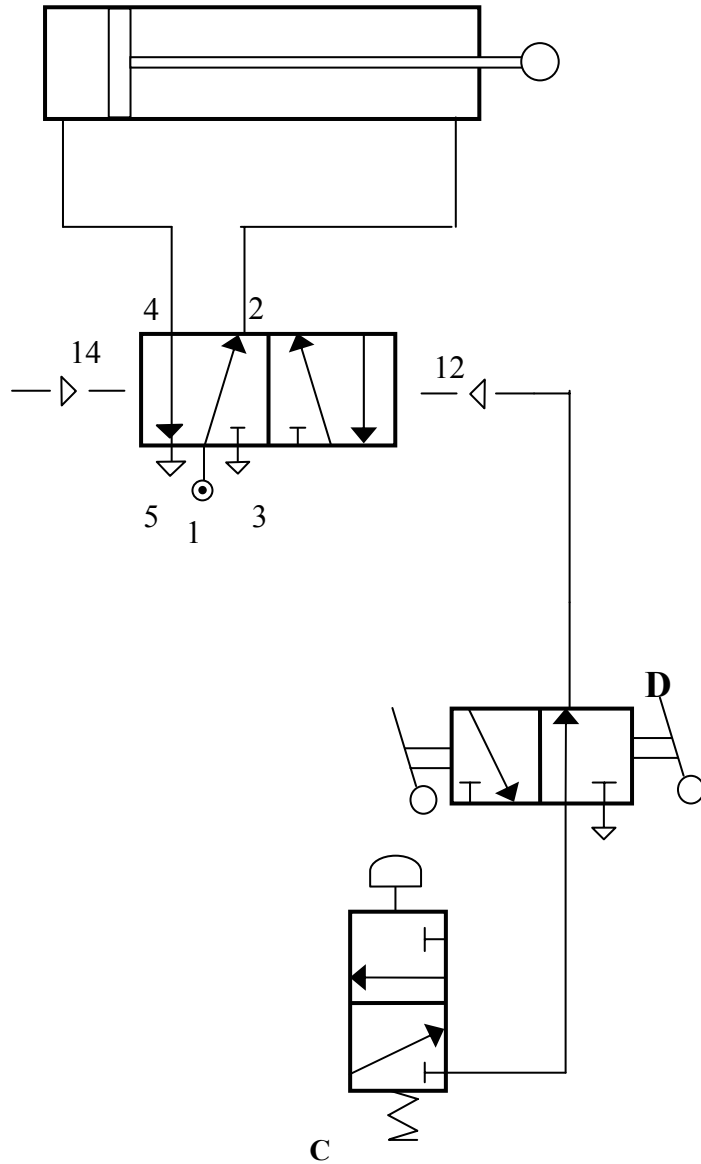


Fig 12 (a)



Pro forma Answer No 12 (b)

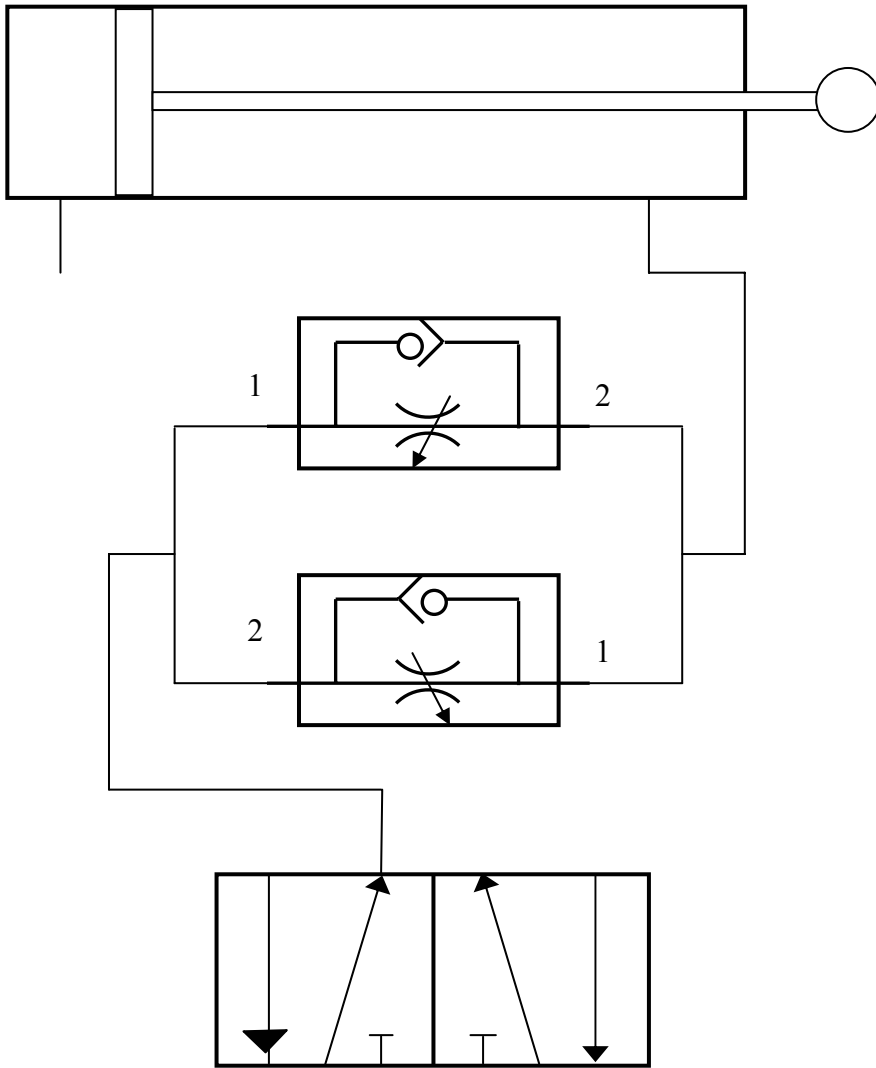


Fig 12 (c)



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Technology and Design

Assessment Unit A2 1

assessing

Systems and Control

SPECIMEN PAPER

TIME

2 hours

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number on the answer booklet provided and on the A3 pro forma pages provided.

Answer **EITHER** the **two** questions in Section A **or** the **two** questions in Section B.

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 2(c) and 4(e).

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

At the conclusion of the examination, attach the A3 pro forma answer pages securely to the Answer Booklet with the treasury tag supplied.

Section A

Electronic/Microelectronic Systems

Answer **both** questions in this section.

- 1 (a) The thermistor is a device which is often used as a sensor for the measurement of temperature. State the principle physical property of the thermistor that is utilised in temperature measurement. Illustrate your answer with a suitable sketch. [4]
- (b) The thermistor is usually connected in series with a resistor as shown in Fig 1 (a). [4]
- (i) Briefly state the purpose of this arrangement of the thermistor and resistor. [4]
- (ii) Find the value of voltage V_1 when the thermistor resistance is $5\text{ k}\Omega$ at 0°C and $2\text{ k}\Omega$ at 10°C . [4]
- (c) The opamp, OA1, in Fig 1 (a) is connected as a difference amplifier having an output voltage, $V_o = (R_F/R_1)(V_1 - V_2)$. The output voltage V_o is to range from 0 V to $+2\text{ V}$ as the temperature goes from 0°C to 10°C . Determine: [4]
- (i) suitable values for R_2 and R_3 . [4]
- (ii) the gain of the difference amplifier. [6]
- (iii) suitable values for R_F and R_1 . [2]

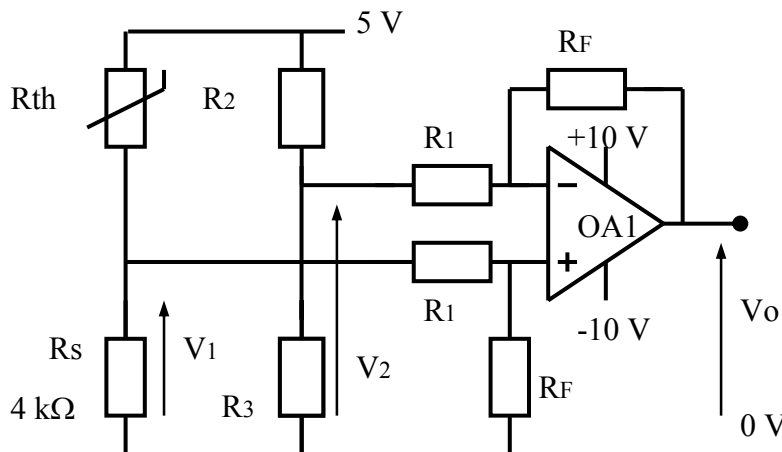


Fig 1 (a)

(d) The circuit shown in **Fig 1 (b)** is now connected to that of **Fig 1 (a)**; the output V_o of **Fig 1 (a)** is the input to **Fig 1 (b)**. The purpose of this circuit is to indicate if the temperature is above or below the reference temperature determined by the setting of the potentiometer R_v .

(i) Briefly explain the operation of the circuit. [6]

(ii) Deduce which LED is illuminated when the temperature being measured is above the reference temperature. [6]

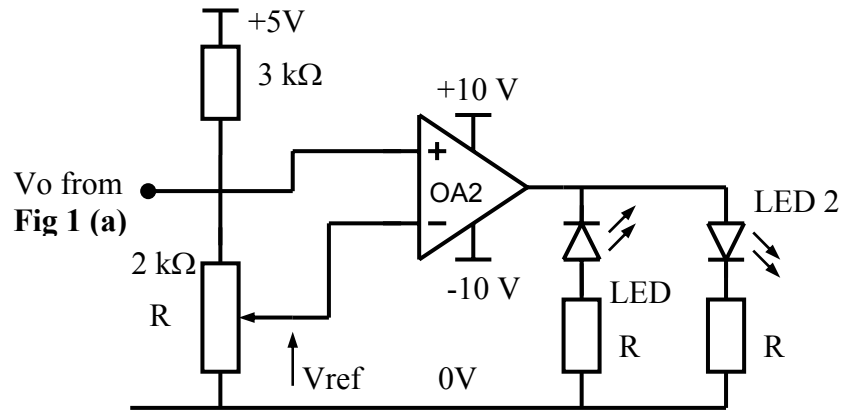


Fig 1 (b)

2 Access to a clean room is via three doors A, B and C in succession. The correct opening of the doors is when any one door or any two adjacent doors can be open. The incorrect usage is when the outer doors or all three doors are open. Each door creates a logic '1' signal only when open.

A system is to be designed to indicate:

- when personnel are entering or leaving the clean room and using the doors in the correct manner; and
- that the doors are being used incorrectly.

(a) (i) Draw up a truth table to represent each of the conditions stated above. [8]

(ii) Deduce the logic expression for each of the conditions. [6]

(iii) Minimise each expression. [6]

(iv) Draw the logic circuits. [6]

(b) The system is to be extended by having a circuit, which is triggered when an incorrect usage of the doors is detected and is to remain in this state until it is reset. The circuit shown in **Fig 2** could be used for this purpose.

(i) Briefly describe how the circuit operates. [6]

(ii) Show how the circuit could be connected to one of the circuits designed in part (b). [5]

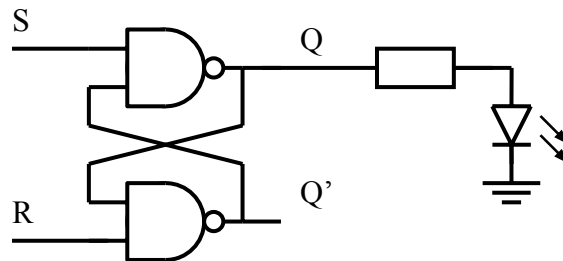


Fig 2

(c) Many industrial applications require a 'clean room'. Explain why such a facility might be required and then, using an industry of your choice, discuss why such a facility might be needed, including its advantages and disadvantages. Provide a rationale justifying whether or not a clean room is necessary. [7]

Section B

Pneumatic and Mechanical Systems

Answer **both** questions in this section.

- 3** **Fig 3 (a)** shows part of a proposed new passenger and luggage conveyor system to be tested in an airport. The electrical motor rotates at 360 rev/min and is connected to a gear based transmission system providing a suitable output on output shaft **X** to power the conveyor runners.
- (a)** Using an annotated sketch, briefly explain what is meant by the following terms associated with gears.
- (i)** Pitch circle diameter. [2]
- (ii)** Pitch point. [2]
- (b)** The gear based transmission system has a garter spring seal to prevent lubrication escaping onto output shaft **X**.
- (i)** Lubrication reduces friction and wear. Briefly describe one further generally unwanted side effect associated with friction in a mechanical system. [2]
- (ii)** Using an annotated sketch, briefly outline this type of seal arrangement. [6]
- (c)** In order to ensure a steady flow of passengers, a turnstile, shown in **Fig 3 (b)** is erected at the entrance to the conveyor system. Using an annotated sketch, name and draw a suitable bearing and housing at H to ensure a smooth turning operation. [8]
- (d)** **Fig 3 (c)** shows the gear based transmission system in detail.
- (i)** Calculate the overall velocity ratio of the gear based transmission system. [6]
- (ii)** One rotation on output shaft X produces a linear movement of 20cms on the conveyor mat. Calculate the linear distance moved by a passenger during 20 seconds of operation if the motor rotates at 360 rev/min. [6]
- (iii)** Calculate the input torque from the motor if output torque available on auxiliary output shaft Y is 120Nm. [6]

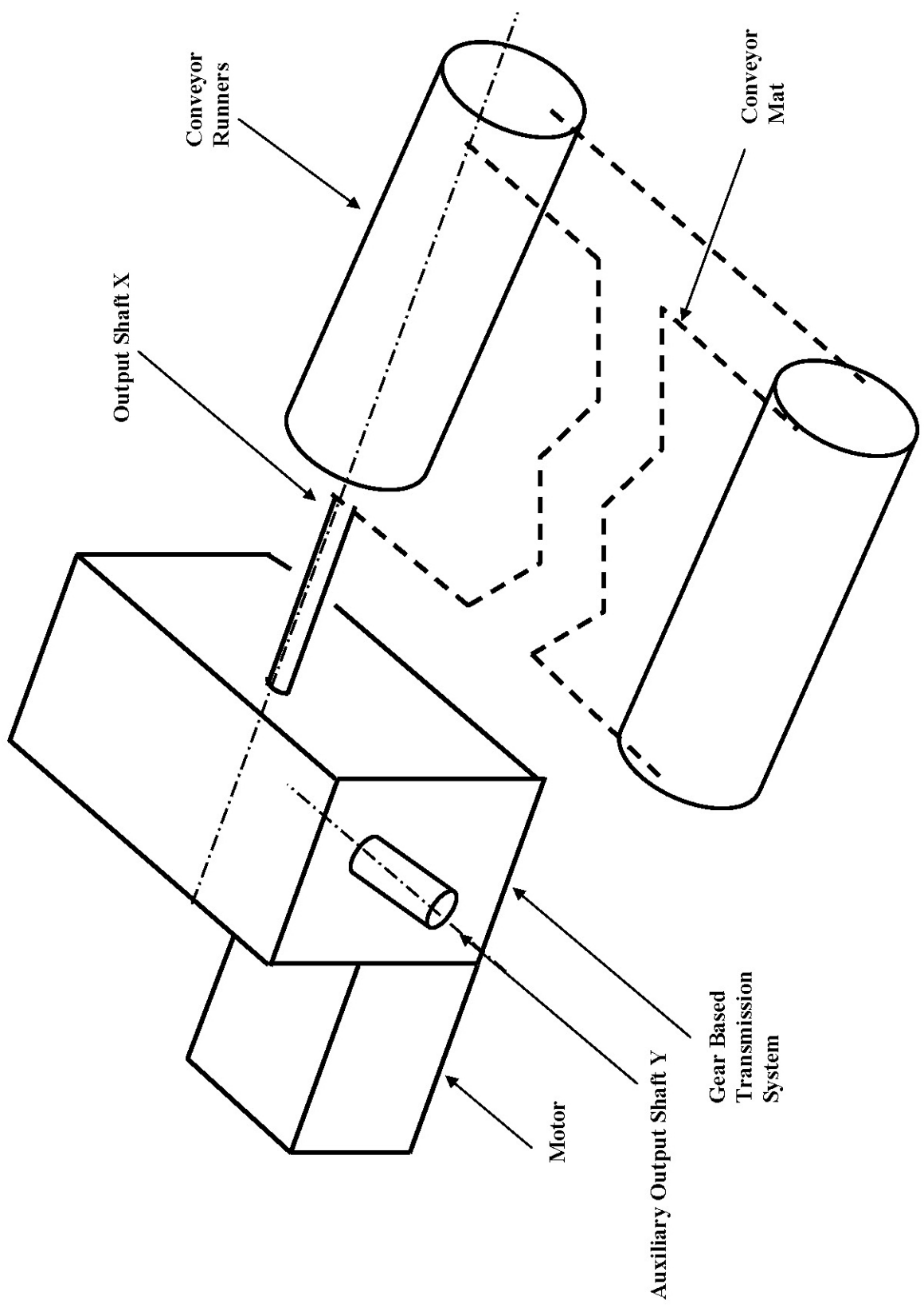


Fig 3 (a)

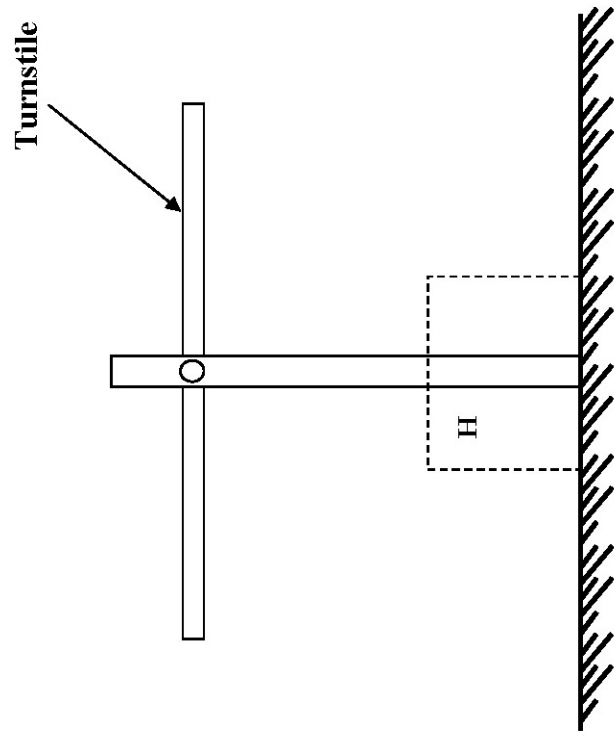


Fig 3 (b)

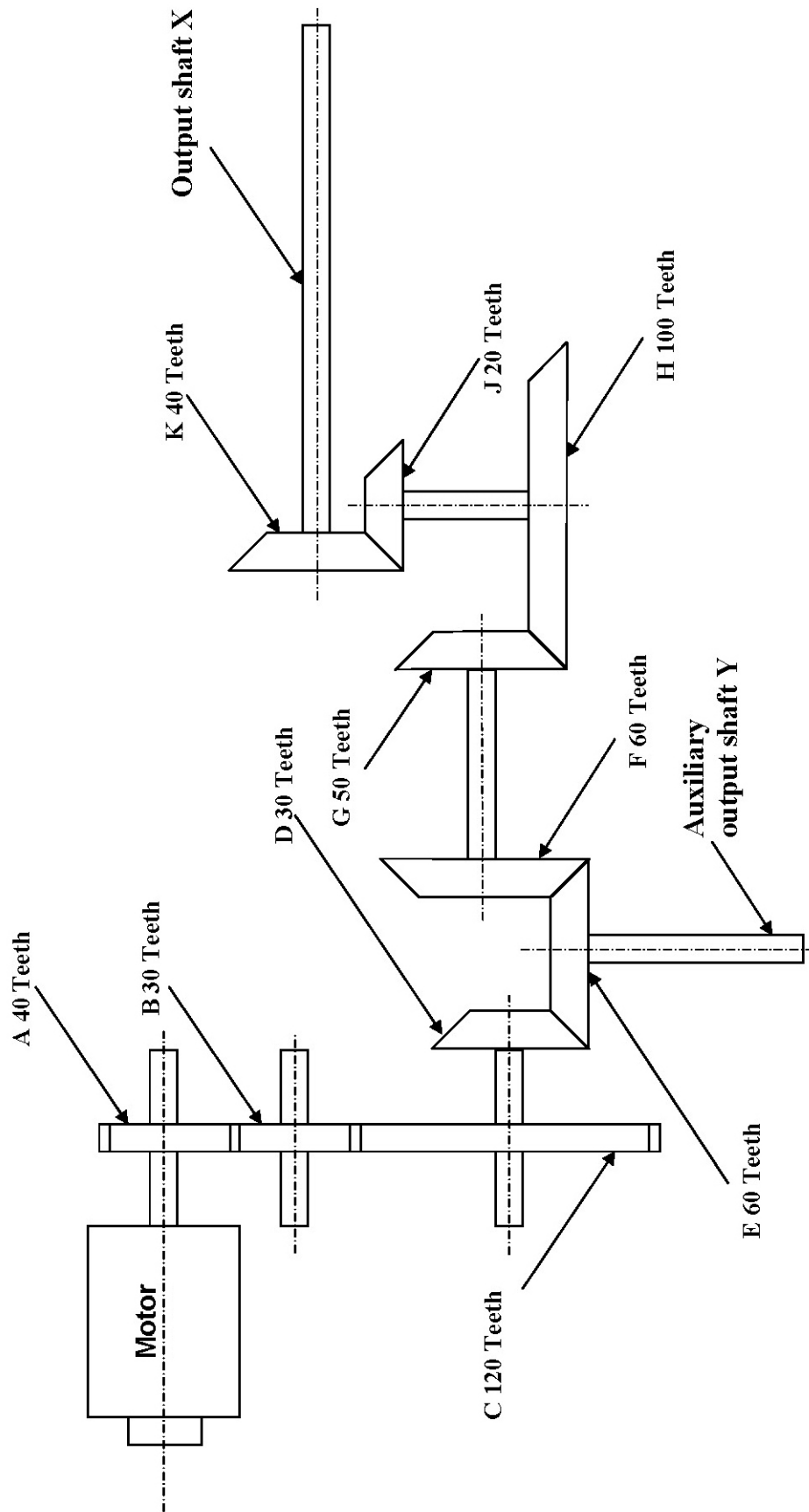


Fig 3 (c)

- 4 **Fig 4 (a)** shows a prototype load tipping system to be used on a small lorry. Cylinder **A** opens and closes the side door and cylinder **B** raises the main container body to tip the contents out and lower it again.
- (a) The lorry shown in **Fig 4 (a)** uses disc brakes on the front wheels and drum brakes on the back wheels.
- (i) Briefly explain **two** main reasons for this braking arrangement. [4]
- (ii) Using an annotated sketch outline the main features of a typical drum brake. [5]
- (b) Using an annotated sketch, name and draw a suitable linkage system to oscillate a windscreen wiper used on the lorry. This system is powered by an electric motor. [4]
- (c) **Fig 4 (b)** shows an incomplete circuit intended to pneumatically control the load tipping system. The proposed sequence required to perform the tipping operation is **A+B+A-B-** with **A** and **B** instroking after a delay in time. On the pro forma provided (Answer 4 (b)) complete the circuit to perform the desired sequence. [10]
- (d) During testing it was found that occasionally some of the contents held in the main container body did not slide out during tipping and remained causing a blockage. **Fig 4 (c)** shows a possible method using a cylinder **C** connected to a movable inner wall to push out any blocked materials. **Fig 4 (d)** shows an incomplete electro-pneumatic circuit to be used to control cylinder **C**. The completed circuit is intended to provide a semi-automatic operation.
- (i) On the pro forma provided (Answer 4 (d)) complete the electro-pneumatic circuit to enable the outstroke to be manually operated using the push-to-make switch. [6]
- (ii) On the pro forma provided (Answer 4 (d)) complete the electro-pneumatic circuit to enable the instroke of the piston to be automatic using the electrical microswitch. [6]
- (e) Evaluate and discuss the safety implications of using a load tipping system. Your answer should identify the main health and safety hazards and how these can be minimised for the user. [7]

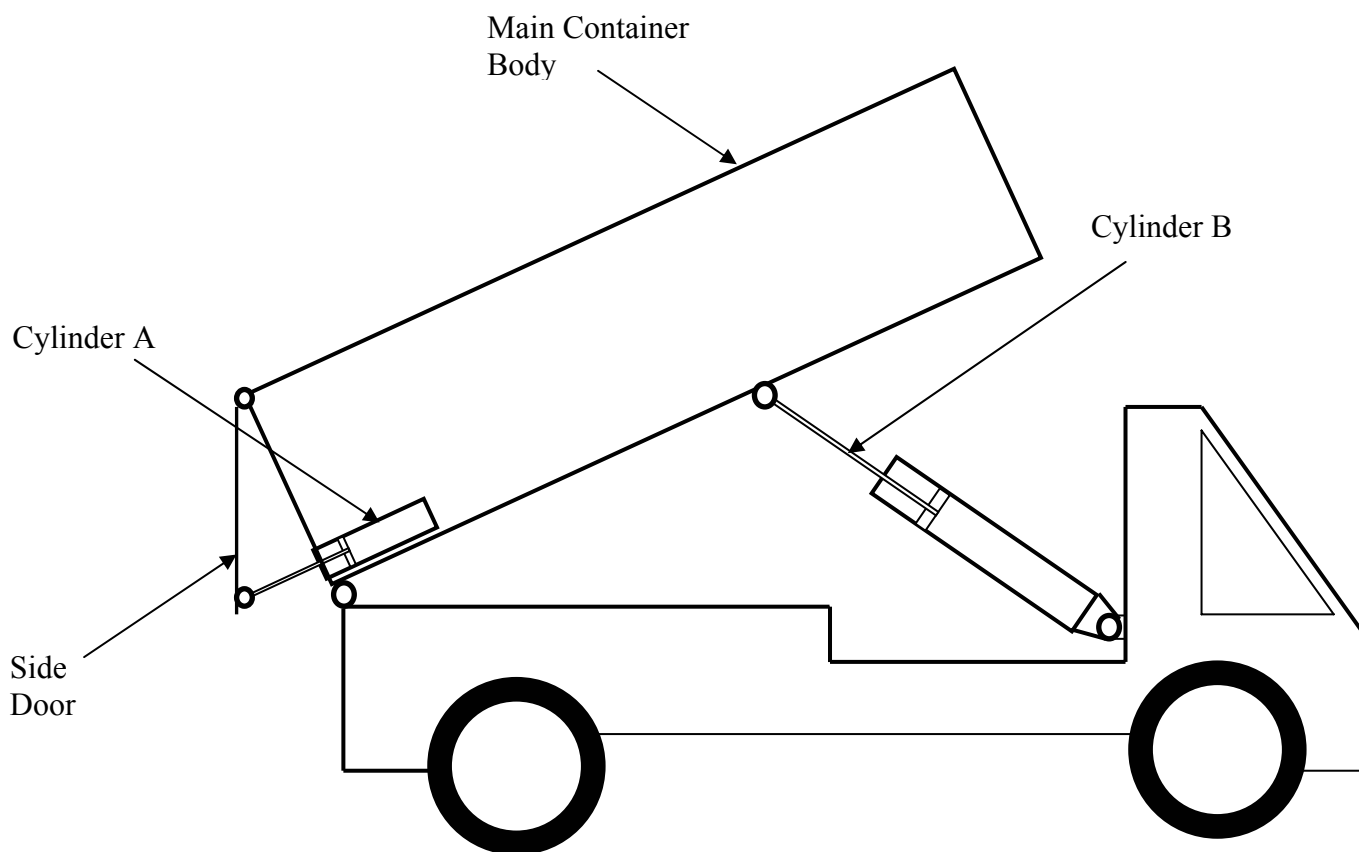
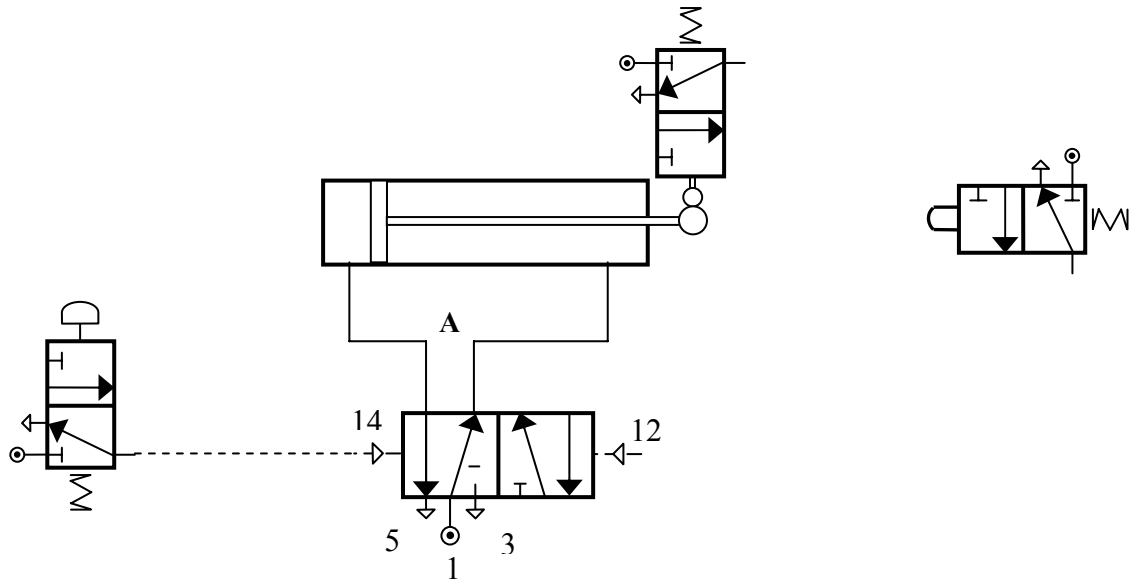


Fig 4 (a)



Start 3PV

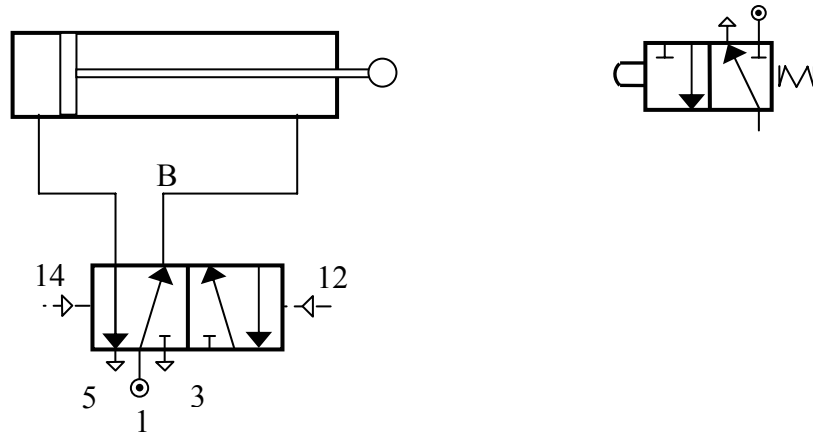
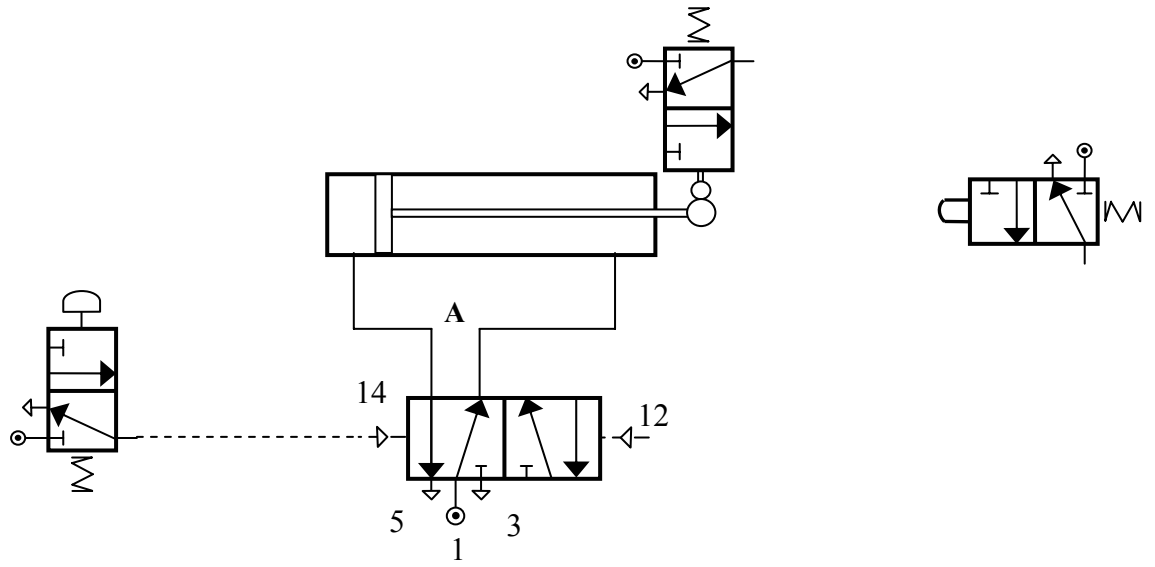
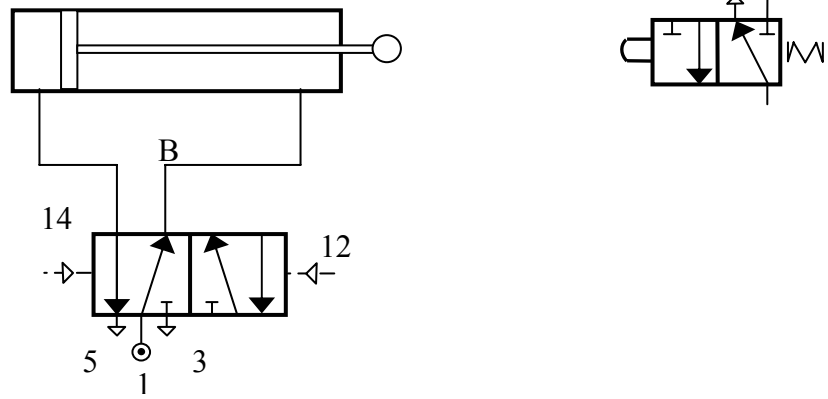


Fig 4 (b)



Start 3PV



Pro forma Answer No 4 (b)

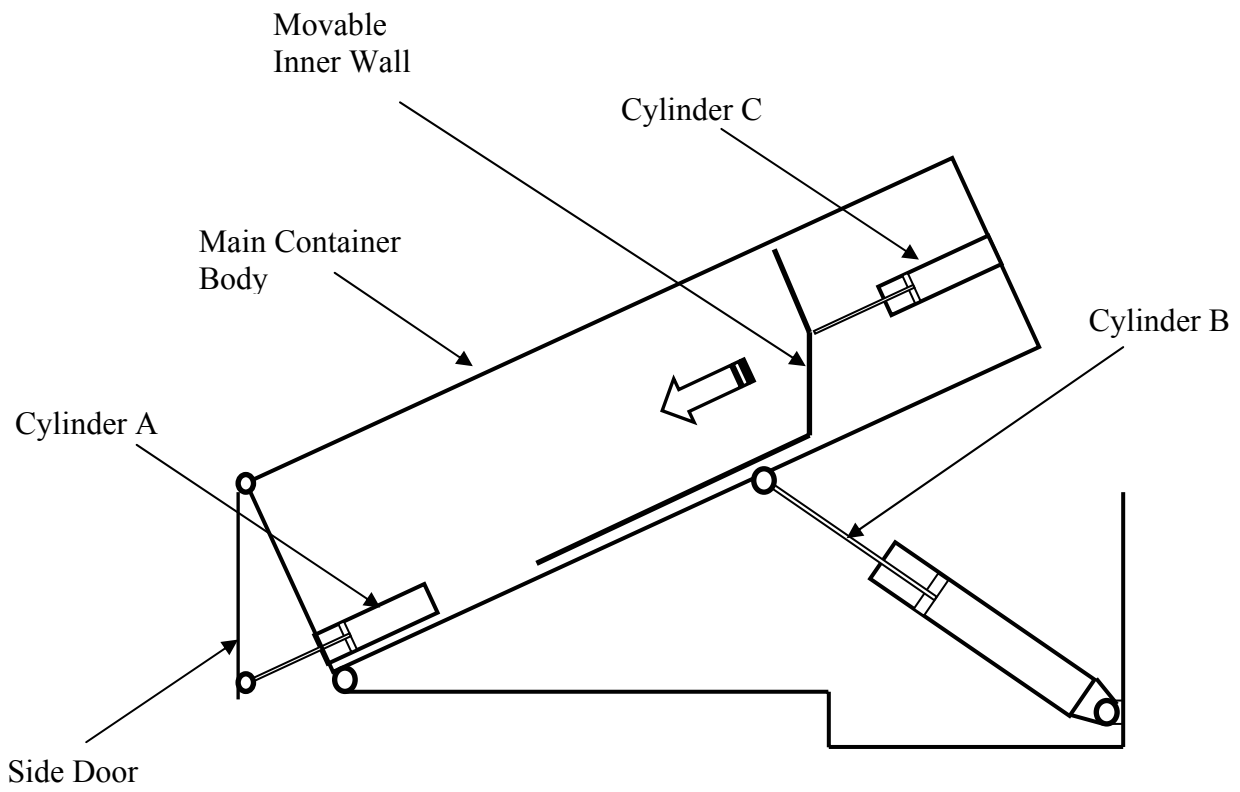


Fig 4 (c)

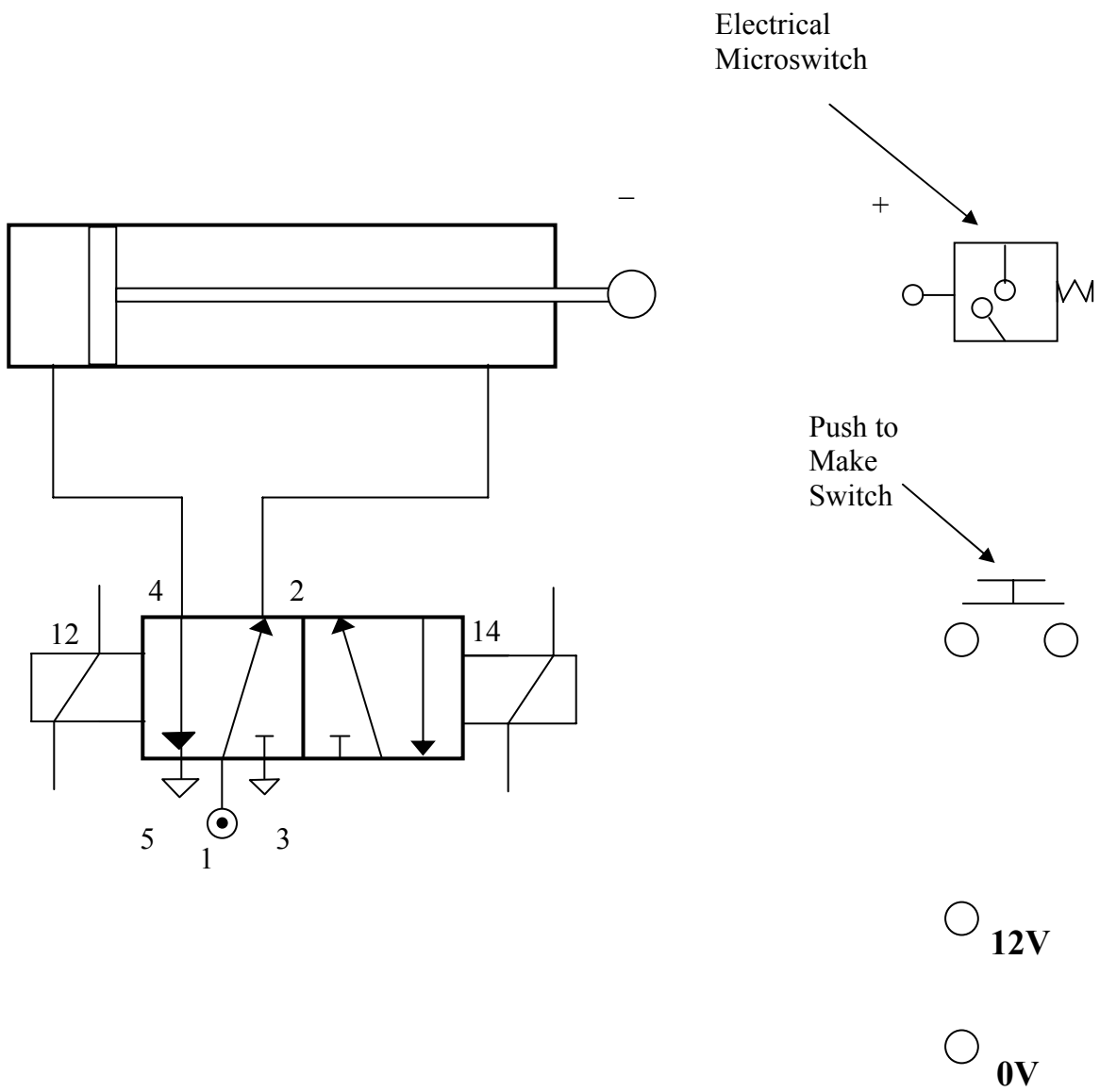
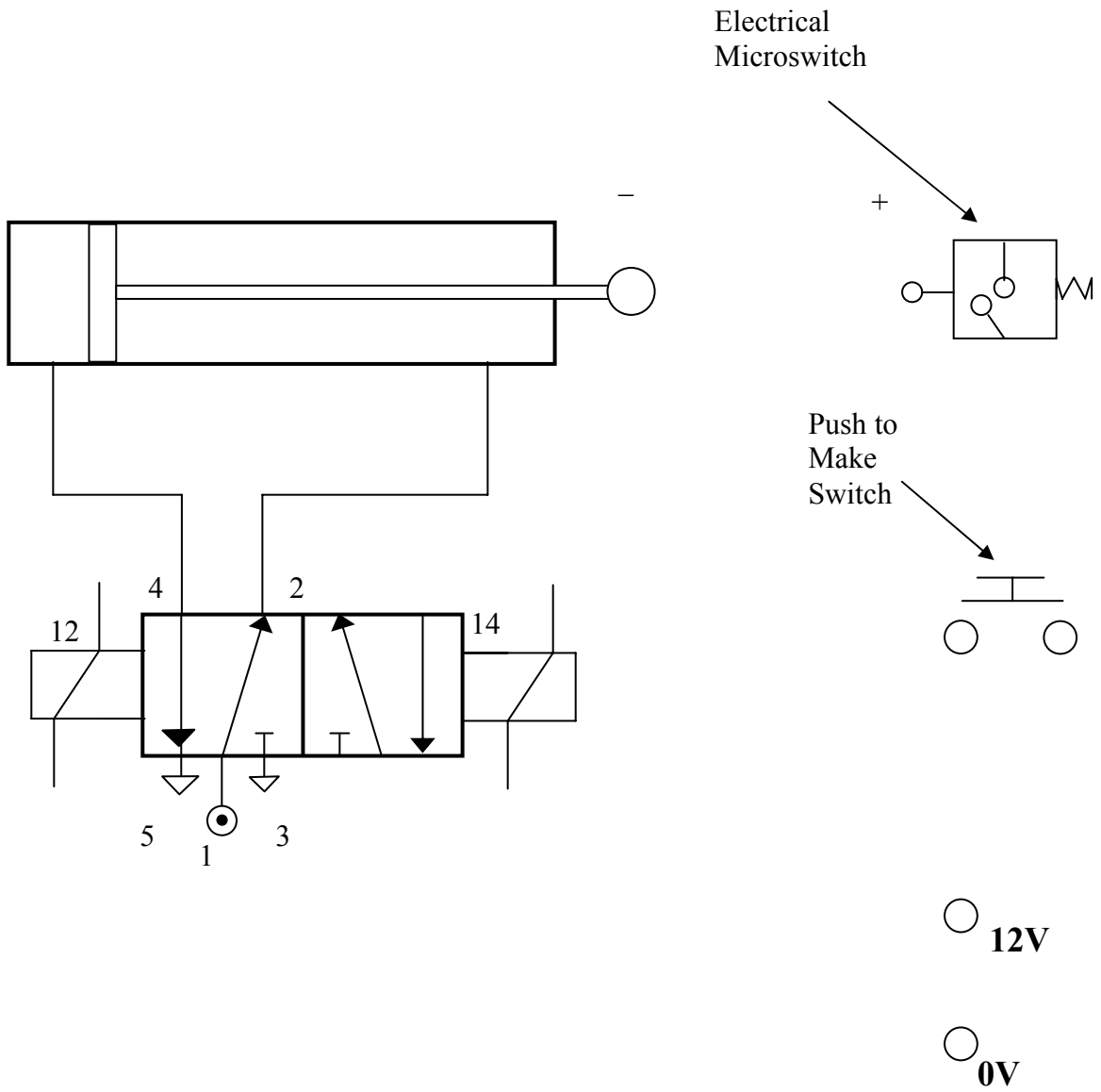


Fig 4 (d)



Pro forma Answer 4 (d)

Mark Schemes



**ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2009**

Technology and Design

Assessment Unit AS 1

Product Design and Systems and Control

SPECIMEN PAPER

**MARK
SCHEME**

General Marking Instructions

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

Quality of candidates' responses

In marking the examination papers, examiners will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

Flexibility in marking

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected for 17- and 18-year-old candidates. Conversely, marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

Types of mark schemes

Mark schemes for questions which required candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper.

Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form. These questions are marked on the basis of levels of response.

Levels of response

Questions requiring extended written answers are marked in terms of levels of response. In deciding which mark within a particular level to award any response, examiners are expected to use their professional judgement. The following guidance is provided to assist examiners.

Threshold performance: Response which just merits inclusion in the level and should be awarded a mark at or near the bottom of the range.

Intermediate performance: Response which clearly merits inclusion in the level and should be awarded a mark at or near the middle of the range.

High performance: Response which fully satisfies the level description and should be awarded a mark at or near the top of the range.

Section A

- 1 (i) Identification of the four elements as tensile, compressive, torsional and shear. 4 × ½ [2]
- (ii) Typical Example:
- tensile – mild steel, medium and high carbon steel;
 - compressive – cast iron;
 - torsional – medium and high carbon steel;
 - shear – high carbon steel.
- 4 × ½ [2]
- 2 (i) Any **two** from the following:
- consistently accurate dimension produced;
 - high quality finish;
 - a wide range of complex forms can be produced;
 - fast production method with little waste.
- 2 × 1 [2]
- (ii) Any **one** material from the following:
- polythene;
 - polystyrene;
 - polypropylene;
 - nylon.
- [1]
- (iii) Suitable sketch of the injection process to include the hopper, screw, heater and mould. [1]
- Description of the flow of granules in the hopper to the opening of the split mould. [1]
- 3 (i) Chipboard melamine – chips of wood mixed with synthetic glue pressed and sandwiched between a plastic layer.
- Plywood – is made up of three or more layers (or veneers) of wood glued together and arranged so that their grains run in alternative directions.
- MDF – fibres of wood mixed with synthetic glue and subjected to very high pressure and heat. [3]

- (ii) Reference to any **two** of the properties from the following:
- good aesthetics properties;
 - good strength to weight ratio;
 - good stability properties;
 - available in a range of colours and patterns.
- 2 × ½ [1]

- 4 (i) Identify any **two** creativity techniques from the following:
- brainstorming;
 - attribute analysis or morphological analysis;
 - lateral thinking.
- [1]

- (ii) Any **two** characteristics for brainstorming from the following:

- no criticism of any ideas allowed/all ideas welcome;
- set time provided;
- group of people used.

Any **two** characteristics for attribute analysis from the following:

- tabular form of representation;
- main characteristics are set out in headings with possible options;
- produces a large number of possibilities.

Any **two** characteristics for lateral thinking from the following:

- looking at things differently;
 - recognise what ideas dominate the design;
 - using chance.
- [4]

- 5 Typical example:

- Culture changes/design influence;
 - Reference to changes in environmental concerns – engine design and fuel use;
 - Reference to changes in safety – internal developments in safety design.
- [2]

Social changes/design influence:

- Reference to the change of the age group of drivers – a range of physical changes to the car;
 - Reference to how the car is used – internal developments of the family car or developments in communications for business or pleasure.
- [2]

1 mark for clear and coherent explanation using good English grammar. [1]

- 6 Stock Control - any **two** from the following:
- recording of stock in and out;
 - automatic recording of material stock level;
 - bar coding indicating information regarding manufacture. [2]
- Modelling - any **two** from the following:
- presentation to client;
 - testing/simulation for assembly;
 - virtual reality testing for consumer groups. [2]
- CAD/CAM - any **two** from the following:
- various design work using CAD;
 - CAM control of injection moulding process;
 - CAM used for construction of prototypes. [2]
- 2 marks for a clear and coherent discussion, including good use of English grammar. [2]
- 7 *BSI for drawing* – reference to the drawing conventions used on the leaflet complying with the standard set by the British Standards Institute. [1]
- Factor of Safety* – reference to the safety margin (factor) that the designer has allowed for in the design above that which the shelf would normally be expected to carry. [1]
- Knockdown fittings* – fittings which are made up of a number of components and are used as the joining method in order to assemble the wardrobe. [1]
- Standard components* – reference to components which are a standard size, use standard manufacturing processes or standard materials. [1]
- 8 (i) Any **one** negative aspect to the pattern of employment:
- redundancies due to shift in employment structure;
 - reduction in labour force. [1]
- Any **one** positive aspect to the pattern of employment:
- new employment opportunities;
 - opportunities for some to develop new skills. [1]

(ii) Any **two** economic considerations for the employer:

- redundancy payments;
- cost for new equipment/technology;
- cost of training and developing new skills;
- cost to recruit and advertising.

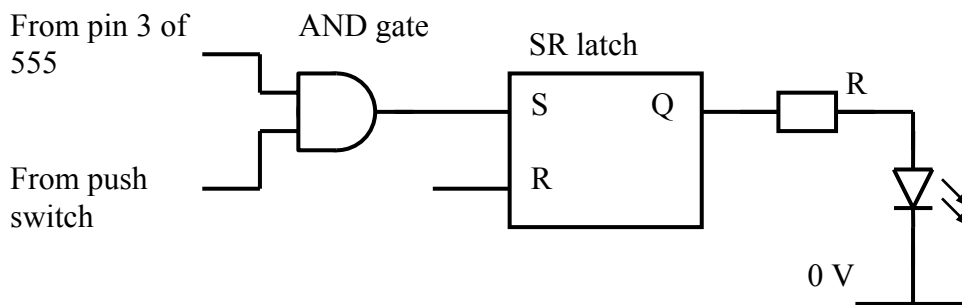
[2]

1 mark for clear and coherent explanation to include good use of English.

[1]

Section B

- 9 (a) (i) Resistance value = $(12 - 2)V/20mA = 500\Omega$ [2]
- (ii) Select $560\ \Omega$ resistor [2]
- (iii) Power = $V \times I = 10V \times 20\ mA = 200\ mW$. Select $0.25\ W$ resistor [2]
- (b) (i) When pin 2 is held 'high' the output is $0\ V$, and the capacitor is uncharged.
When pin 2 is momentarily grounded the output goes 'high' ($9\ V$) and the capacitor commences to charge until voltage at pin 6 = $9V \times 2/3 = 6\ V$. Capacitor is now discharged and pin 3 returns to $0\ V$ [4]
- (ii) $T = 1.1 \times C \times R_a$, so $R_a = T/(1.1 \times C)$
 $T = 0.2\ s$; $R_a = 0.2/(1.1 \times 10^{-5}) = 18\ k\Omega$
 $T = 1.0\ s$; $R_a = 1.0/(1.1 \times 10^{-5}) = 91\ k\Omega$ [4]
- (c) (i) An AND gate is a suitable detector [1]
- (ii) Since the output from the AND gate is a short pulse an SR latch is needed to detect it and also switch on a LED. [4]



- 10 (a) (i) Reed switch [1]
- (ii) $hFE = I_c/I_b$ [1]
- (iii) $I_c = 12V/40\ ohm = 200mA$
therefore $hFE = 200/5 = 40$ [2]

- (iv) Window is opened:
- switch is opened so voltage at base is low;
 - transistor is therefore switched off;
 - relay is not energised; [3]
 - switch position changes and bell is switched on. [1]

(v) To prevent back emf from damaging TR 1

(b)

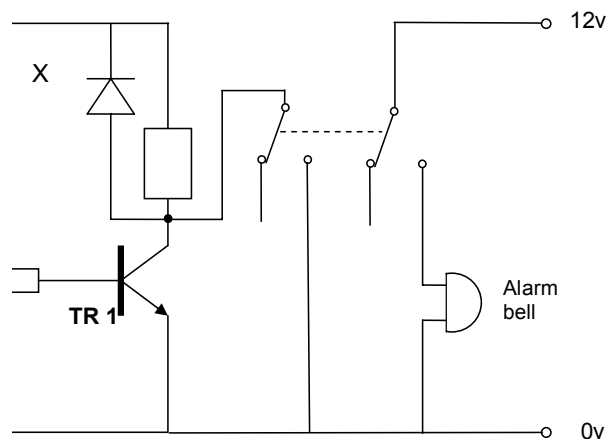


Fig 10

[4]

(c) (i)

A	B	C	D	E	Q
0	0	1	1	1	0
0	1	1	1	0	1
1	0	1	0	1	1
1	1	0	1	1	0

1 mark for each correct column ($4 \times [1]$) [4]

(ii) Exclusive OR (EXOR) [1]

(iii) To ensure a high or logic 1 when the switches are not pressed [2]

(iv) **Advantages:** lower component count, can be easily changed, smaller PCB
Disadvantages: still quite expensive, more difficult to fault find (can be hardware or software problems) ($4 \times [1/2]$) [2]

Section C

- 11 (a) Name the type of mechanical component used at A

Ans = Bevel gear [1]

- (b) State the direction of rotation at G if the motor rotates clockwise.

Ans = Anti-clockwise/different direction. [1]

- (c) (i) Calculate the overall velocity ratio from mechanical component A to the output at J.

VR = No teeth driven/No teeth driver

$$25/50 = 1/2$$

$$60/20 = 3$$

$$30/90 = 1/3$$

Ans = $\frac{1}{2} \times 3 \times \frac{1}{3} = 0.5$ [4]

- (ii) Calculate the speed at output E if the motor rotates at 480 rev/min.

VR = No teeth driven/ No teeth driver

$$25/50$$

$$40/1$$

$$1/2 \times 40 = 20$$

OS=IS / VR

OS=480 /20 = 24 [5]

- (iii) An alternative component assembly to the one outlined in Fig 11 (a) has an efficiency of 87.5% and a mechanical advantage of 7. Showing all calculations determine the velocity ratio of the new assembly.

Efficiency = MA/VR \times 100%

$$87.5 = 7/?$$

Ans = 8 [2]

- (d) (i) Pulley J is secured to the shaft using a grub screw. Using an annotated sketch draw this method of fixing to shafts.

Suitable annotated sketch of grub screw

Grub screw [1]

Housing/

Position [2]

(ii) Name one other method used to fix mechanical components to shafts.

Cotter pin/key and keyway

[1]

(e) Name and sketch an alternative method of transferring rotary motion from shaft **X** to shaft **Y**.

Round belt

[1]

Sketch of belt

[1]

Position

[1]

Or other suitable answer.

12 Name the methods of operating the following three port valves:

(a) **(i)** at **A** – Ans = Diaphragm

[1]

(ii) at **B** – Ans = Lever set/reset

[1]

(b) What is the logic term given to the function of component **D**.

Ans = Not gate

[2]

(c) **(i)** On the pro forma provided (answer No 3(c)(i)) complete the circuit to enable the double acting cylinder to outstroke if either **A** or **B** is activated and **C**

Main air supply A

[1]

Main air supply B

[1]

Connect A to FCV

[1]

Connect B to FCV

[1]

FCV

[2]

FCV to C

[1]

(ii) Briefly describe what happens if the three port valves **A**, **B** and **C** are activated at the same time.

A or B also functions as an AND gate.

When all three are activated the air passes from A and B through C and to the 5Pv.

[2]

(iii) On the pro forma provided (answer No 3 (c)(i)) complete the circuit to enable the double acting cylinder to instroke following a full outstroke.

3PV positioned to be activated once DAC positive

[2]

Suitable 3PV activation method

[1]

3PV connected to 12 port on 5PV

[1]

- (d) **Fig 12 (c)** shows two components R and S connected between the five port valve and the double acting cylinder to control the speed of the outstroke.

Briefly explain why this arrangement would fail to function properly

FCV wrong way around

[1]

One cancels the other out

[1]

Exhaust air is allowed to flow freely

[1]



**ADVANCED
General Certificate of Education
2010**

Technology and Design

Assessment Unit A2 1

Systems and Control

SPECIMEN PAPER

**MARK
SCHEME**

General Marking Instructions

These mark schemes are intended to ensure that the AS/A2 examinations are marked consistently and fairly. The mark schemes provide examiners with an indication of the nature and range of candidate responses likely to be worthy of credit. They also set out the criteria which they should apply in allocating marks to candidates' responses. The mark schemes should be read in conjunction with these general marking instructions which apply to all papers.

Quality of candidates' responses

In marking the examination papers, examiners will be looking for a quality of response reflecting the level of maturity which may reasonably be expected of 17- and 18-year-olds which is the age at which the majority of candidates sit their AS/A2 examinations.

Flexibility in marking

The mark schemes which accompany the specimen examination papers are not intended to be totally prescriptive. For many questions, there may be a number of equally legitimate responses and different methods by which the candidates may achieve good marks. No mark scheme can cover all the answers which candidates may produce. In the event of unanticipated answers, examiners are expected to use their professional judgement to assess the validity of answers. If an answer is particularly problematic, then examiners should seek the guidance of the Supervising Examiner for the paper concerned.

Positive marking

Examiners are encouraged to be positive in their marking, giving appropriate credit for valid responses rather than penalising candidates for errors or omissions. Examiners should make use of the whole of the available mark range for any particular question and be prepared to award full marks for a response which is as good as might reasonably be expected for 17- and 18-year-old candidates. Conversely, marks should only be awarded for valid responses and not given for an attempt which is completely incorrect and inappropriate.

Types of mark schemes

Mark schemes for questions which required candidates to respond in extended written form are marked on the basis of levels of response which take account of the quality of written communication. These questions are indicated on the cover of the examination paper.

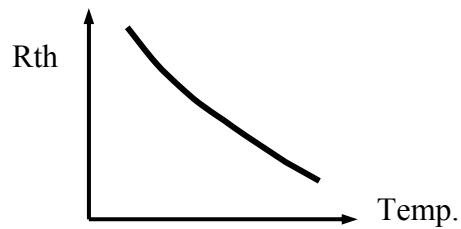
Other questions which require only short answers are marked on a point for point basis with marks awarded for each valid piece of information provided.

Quality of written communication

Quality of written communication is taken into account in assessing candidates' responses to all questions that require them to respond in extended written form.

Section A

- 1 (a) The principle physical property of the thermistor is its negative resistance-temperature characteristic.



[4]

- (b) (i) The variation of R_{th} with temperature caused V_1 to vary, hence the value of V_1 is a measure of temperature.

[4]

(ii) At 0°C $V_1 = (5 \times 4) / (4 + 5) = 1.11 \text{ V}$

At 10°C $V_1 = (5 \times 4) / (4 + 2) = 3.33 \text{ V}$

[4]

- (c) (i) At 0°C $V_o = 0 \text{ V}$, so $V_2 = V_1$ hence R_3 could be $4 \text{ k}\Omega$ and R_2 could be $5 \text{ k}\Omega$, or pairs of resistors in the ratio 4:5.

[4]

- (ii) Resistors R_F and R_1 provide the gain of the difference amplifier. At 10°C $V_o = 2 \text{ V}$, $V_2 = 1.11 \text{ V}$ and $V_1 = 3.33 \text{ V}$.

Hence $2 = (R_F/R_1)(V_1 - V_2) = (R_F/R_1)(2.22)$ so $(R_F/R_1) = 0.9$.

[6]

- (iii) Suitable value of resistance; $R_1 = 200 \text{ k}\Omega$ and $R_F = 180 \text{ k}\Omega$

[2]

- (d) (i) The reference voltage (temperature) V_{ref} is set by the potentiometer R_v . The opamp OA2 acts as a comparator of the voltages, V_o from **Fig 1 (a)** and the voltage V_{ref} . If $V_o > V_{ref}$ then output of comparator is $\approx +10 \text{ V}$ and LED 2 is illuminated. When $V_o < V_{ref}$ then LED 1 is illuminated.

[6]

- (ii) For this condition $V_o > V_{ref}$ and so output of opamp OA2 is $+10 \text{ V}$ and hence LED 2 is illuminated.

[6]

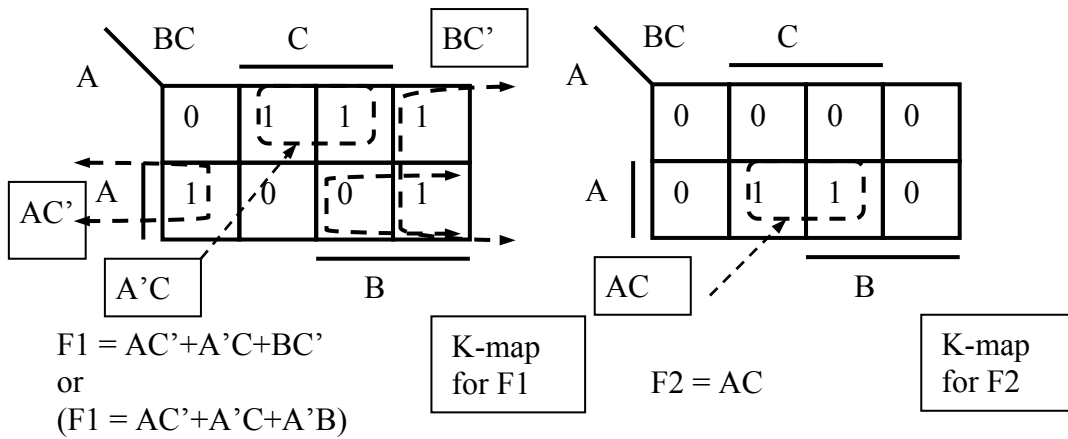
2 (a)

A	B	C	F1	F2
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	1	0
1	0	0	1	0
1	0	1	0	1
1	1	0	1	0
1	1	1	0	1

(i) Truth Table [8]

(ii) Logic expressions [6]

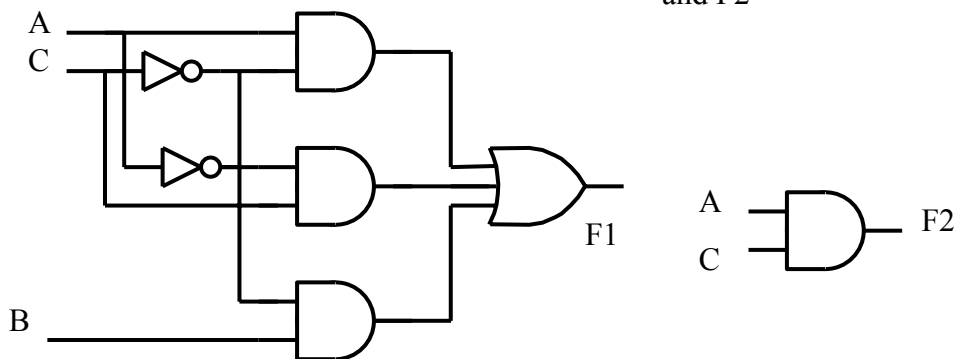
(iii)



(iii) Minimised expressions [4]
[2]

(iv)

(iv) Logic circuits for F1 and F2 [4]
[2]

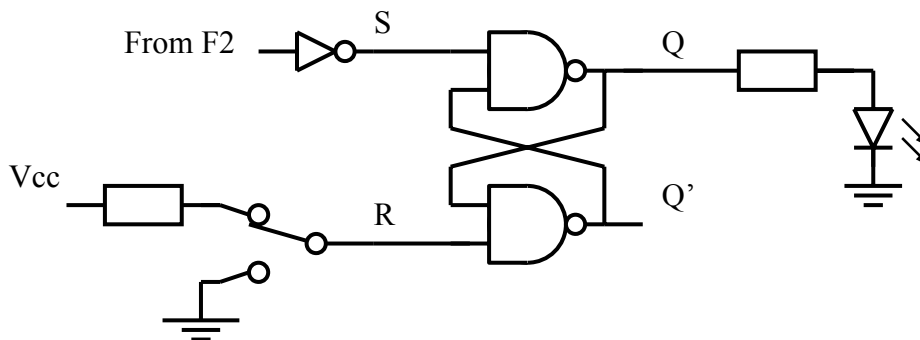


- (b) (i) The circuit is a SR latch. Normally S and R are at logic 1 ie $SR=11$, and let $Q=1$. When S goes to 0, ie input is $SR = 01$, output Q goes to 1; when S returns to 1, input is $SR = 11$, Q remains at 1 until R changes from 1 to 0. The circuit is now reset. ($Q=0$)

[6]

- (ii) SR latch is connected to output F2 via an inverter. A switch is connected to R to reset the latch.

[5]



- (c) Answer to include the types of industries requiring a clean room, and why they would need such a room. Types of advantages and disadvantages must be relevant to, and reflect the type of industry chosen. These may include no cross contamination from skin, no contact with outside air, security of materials, costs of room, time in suiting up, working in protective kit.

The answer must also include a rationale that justifies whether or not the room is necessary.

5 marks

2 marks for a coherent and structured answer which must include good use of English.

[7]

Section B

- 3 (a)** Using an annotated sketch, briefly explain what is meant by the following terms associated with gears:
- (i)** Suitable sketch outlining the main elements of a Pitch circle diameter [2]
 - (ii)** Suitable sketch outlining the main elements of a Pitch point [2]
- (b)** The gear based transmission system has a garter spring seal to prevent lubrication escaping onto output shaft **X**.
- (i)** Lubrication reduces friction and wear. One further generally unwanted side effect associated with friction in a mechanical system is heat.
Or other suitable alternative. [2]
 - (ii)** Using an annotated sketch, briefly outline a garter spring seal arrangement.
- Seal [2]
 - Garter Spring [2]
 - Position on shaft [2]
- (c)** Using an annotated sketch, name and draw a suitable bearing and housing at **H** to ensure a smooth turning operation.
- Thrust Bearing [2]
 - Bearing Sketch [2]
 - Shaft integration [2]
 - Housing [2]

- (d) (i)** Calculate the overall velocity ratio of the gear based transmission system.

$$\begin{array}{l} \text{VR} \quad \text{A-C}=3 \\ \text{VR} \quad \text{D-F}=2 \end{array} \quad [2]$$

$$\begin{array}{l} \text{VR} \quad \text{G-H}=2 \\ \text{VR} \quad \text{J-K}=2 \end{array} \quad [2]$$

$$\begin{array}{l} \text{Total VR } 3 \times 2 \times 2 \times 2 = 24 \\ \text{ans VR} = 24 \end{array} \quad [2]$$

- (ii)** One rotation on output shaft **X** produces a linear movement of 20cms on the conveyor. Calculate the linear distance moved by a passenger during 20 seconds of operation if the motor rotates at 360 rev/min.

$$\begin{array}{l} \text{Output speed} = \text{Input speed} \times \text{VR} \\ 360/24 = 15 \text{ rev/min} \end{array} \quad [2]$$

$$5 \text{ revs in } 20 \text{ secs} \quad [2]$$

$$\begin{array}{l} 5 \times 20 = 100 \text{ cms} \\ \text{ans} = 100 \text{ cms} \end{array} \quad [2]$$

- (iii)** Calculate the input torque from the motor if output torque available on auxiliary output shaft **Y** is 120Nm.

$$\text{VR } 3 \times 2 = 6 \quad [2]$$

$$\begin{array}{l} \text{Output Torque} = \text{Input Torque} \times \text{VR} \text{---} 120/6 = 20 \\ \text{ans} = 20 \text{ Nm} \end{array} \quad [4]$$

- 4 (a) The lorry shown in **Fig 4 (a)** uses disc brakes on the front wheels and drum brakes on the back wheels.
- (i) Briefly explain **two** main reasons for this braking arrangement.
- Much of the stopping force is experienced in the front wheels
- The Disc brakes are more efficient and effective than drum brakes
- Drum brakes are less expensive than disc brakes
- Any other suitable answer [4]
- (ii) Using an annotated sketch outline the main features of a typical drum brake.
- Outer Drum [1]
- Brake shoes [2]
- Hydraulic/lever/cam operation [2]
- (b) Using an annotated sketch, name and draw a suitable linkage system to oscillate a windscreen wiper used on the lorry. This system should be powered by an electrical motor.
- Treadle linkage [2]
- Sketch showing rotary to oscillating motion [2]
- Or other suitable alternative
- (c) **Fig 4 (b)** shows an incomplete circuit intended to control the system. The proposed sequence required to perform the tipping operation is **A+B+A-B-** with **A** and **B** instroking after a delay in time.
- On the pro forma provided (Answer No 5 (c)) complete the circuit to perform the desired sequence.
- Method of activating B+ [2]
- Method of activating A- [2]
- Method of activating B- [2]
- Time delay for A [2]
- Time delay for B [2]

(d) During testing it was found that occasionally some of the contents held in the main container body did not slide out during tipping and remained causing a blockage. **Fig 4 (c)** shows a possible method using a cylinder **C** connected to a movable inner wall to push out any blocked materials. **Fig 4 (d)** shows an incomplete electro-pneumatic circuit to be used to control cylinder **C**. The completed circuit is intended to provide a semi-automatic operation.

(i) On the pro forma provided (Answer 4 (d)) complete the electro-pneumatic circuit to enable the outstroke to be manually operated.

Connection from 12V and 0V through the push-to-make switch and connected to the 14 side of the 5PV.

Or other suitable alternative.

[6]

(ii) On the pro forma provided (Answer 4 (d)) complete the electro-pneumatic circuit to enable the instroke of the piston to be automatic.

Connection from the 12V and 0V through the electrical microswitch and connected to the 12 side of the 5PV

Or other suitable alternative.

[6]

(e) Answer to include hazards involved in release of material from system, the risks associated with raising and lowering of the system, movement of removing of lorry to remove material, uneven distribution of load in lorry when tipping, accidental raising or lowering of the system, overloaded system, fail-safe systems or suitable alternatives. The answer should include an evaluation of the risk associated with each point and how these can be minimised. 5 marks.

2 marks for a coherent and structured answer which must include good use of English.

[7]



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