

External Assessment 2024

ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section **A**

Pages: 12
Questions: 6

Preparation time for this exam: 15 minutes

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items within each question
- Write your answers in the spaces provided in this exam paper.
- The exam is **three (3) hours** in length. The suggested working time is provided in the instructions for each part.
- The Electronics Information Sheet can be used throughout the exam.
- TASC approved scientific calculators can be used throughout the exam.
 - Show your working in answers to numerical questions.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion/criteria.

| Marker use | |
|------------|------|
| C3 | / 36 |

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EXEMPLAR

Guide to Exam Structure

| | Questions available | Questions to answer | Suggested working time | Marks available |
|------------------|---------------------|---------------------|----------------------------------|------------------|
| Section A | 6 | 6 | 36 minutes | 36 marks |
| Section B | 5 | 5 | 36 minutes | 36 marks |
| Section C | 4 | 4 | 36 minutes | 36 marks |
| Section D | 5 | 5 | 36 minutes | 36 marks |
| Section E | 5 | 5 | 36 minutes | 36 marks |
| Totals | 25 | 25 | 180 minutes (3 hours) | 180 marks |

Criterion/Criteria

You **must** make sure your answers address:

- Criterion 3 apply professional electronic engineering practices to safely construct test and evaluate electronic systems.

Question 1

Marker use

a) State two (2) personal hazards and potential harm and ways of reducing harm when soldering a circuit.

/4

i. hazard and potential harm 1:

.....

ii. ways to reduce harm:

.....

iii. hazard and potential harm 2:

.....

iv. ways to reduce harm:

.....

b) When altering a digital circuit on a breadboard, your teacher suggests “disconnect the power before you remove the IC”.

/2

Is your teacher suggesting this to protect you, or to protect the circuit components? Explain your reasoning.

.....

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c) Explain why CMOS IC's are susceptible to damage by static electricity, and state one (1) way this damage can be prevented.

/2

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**Total
Q1
/8**

Question 2

Marker use

You are testing a printed circuit board (PCB) using a digital multimeter.

- a) Explain why using the resistance setting or continuity setting is required for testing the PCB, and using the voltage or current setting is not suitable for testing at this stage.

/2

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The multimeter you have access to only has the resistance setting to test the PCB.

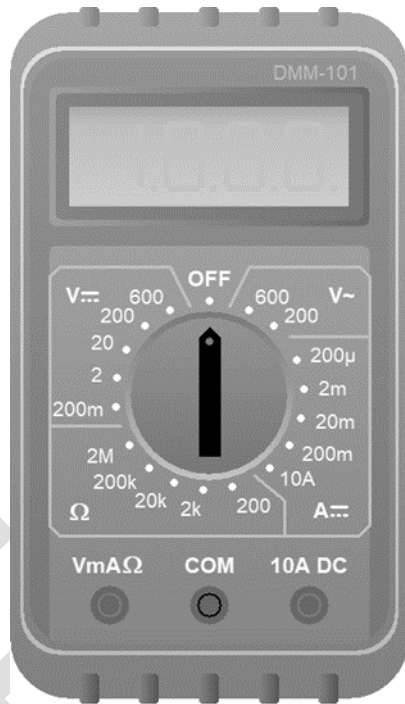


Figure 1: Diagram of a digital multimeter.

- b) Which range would be most appropriate for testing the PCB? Justify your choice with an explanation.

/2

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Question 2 continues

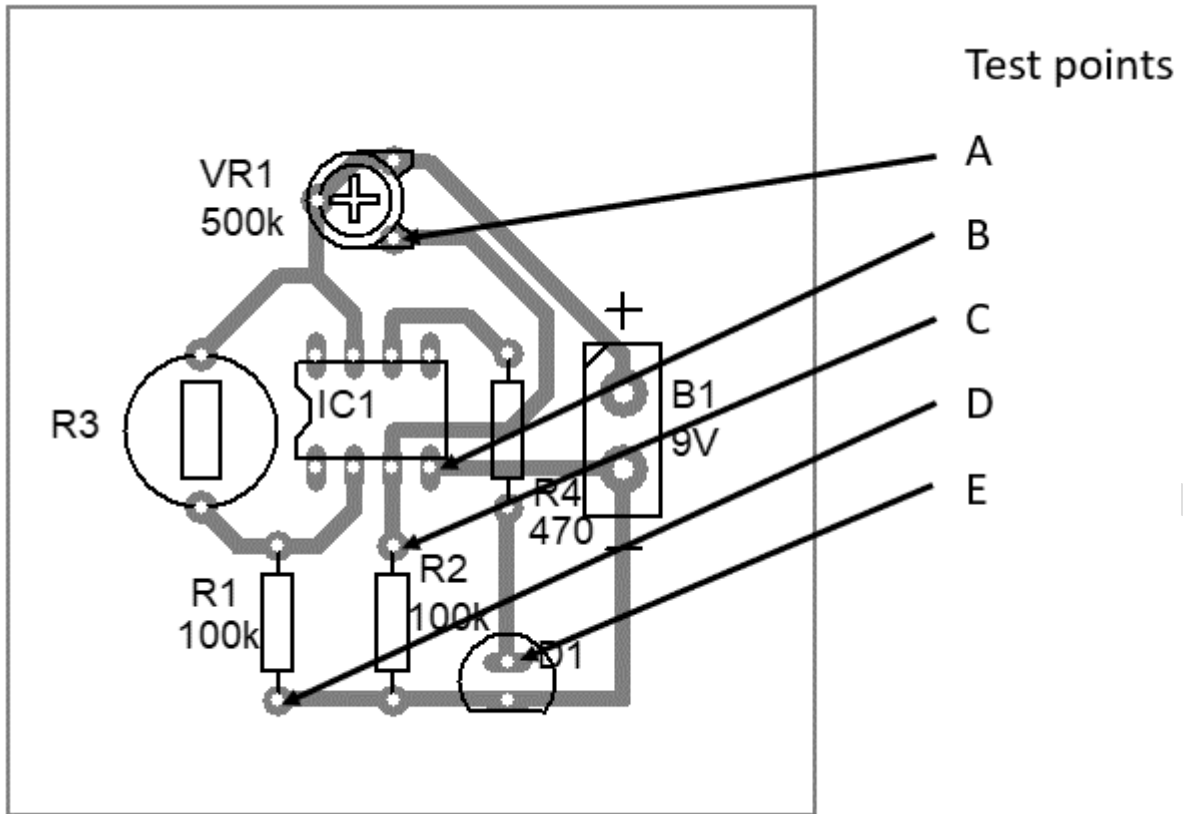


Figure 2: Diagram of the PCB design, highlighting test points A – E.

c) You tested the PCB at the points shown on the PCB design in Figure 2 using the resistance range.

/4

Complete Table 1 indicating whether or not the test shows a fault with the manufactured PCB between those points. Use the words “fault” or “good”.

Note: The PCB design that was manufactured is known to be good, there are no errors in the design, but the manufacturing process used is not 100% reliable. You have not soldered any parts to the PCB yet.

| Test between points | Reading | Fault/good |
|---------------------|---------|------------|
| A & C | | |
| B & C | 00.7 | |
| B & D | 00.9 | |
| B & E | | |

Table 1: Table for providing information about four (4) test point readings to answer Question 2 c).

Total
Q2
/8

Question 3

Marker use

You are designing a project that takes an audio signal from a low power source (e.g. MP3 player) and plays the audio through a low power 8Ω speaker.

- a) Using this information sheet and knowledge of transistor circuits, sketch a schematic of the appropriate choice of circuit.

/2

EXEMPLAR

- b) Explain your reasons for choosing the above circuit. What are some of the limitations and benefits of using such a circuit.

/2

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Total
Q3
/4

Question 4

Marker use

- a) Sketch a schematic of a circuit that has two (2) 1k resistors in parallel as current limiting for a LED, connected to a 9V battery with a toggle switch

/3

The circuit was then built on breadboard, and the switch closed.

- b) You measure the voltage across the LED before and after removing one of the resistors. What changes (if any) do you expect to see to the voltage across the LED? Justify your answer with an explanation.

/2

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- c) Identify two (2) other changes (either observed or measured) that you expect to see when removing the resistor.

/1

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**Total
Q4**

/6

Question 5

Marker use

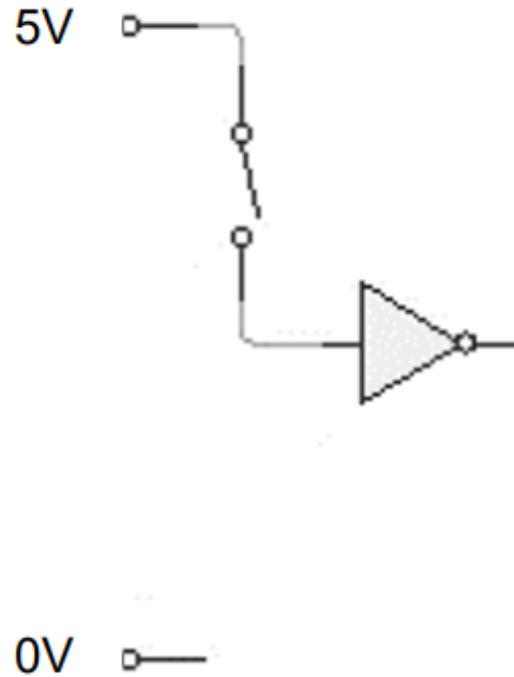


Figure 15 is for an input subsystem for a digital counting circuit

- a) There are two (2) problems with this circuit as it is shown, State and explain the cause of each of these problems, using the appropriate terminology for the issue.

/4

Problem 1:

.....

Problem 2:

.....

- b) Draw on Figure 15 a solution that would solve both problems.

/2

Total
Q5
/6

Question 6

Marker use

Testing circuits can be performed by simulation or breadboarding.

a) State an advantage for each testing method.

/2

Breadboarding:

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Simulation:

.....

b) State a disadvantage of testing each method.

/2

Breadboarding:

.....

Simulation:

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EXEMPLAR

Total
Q6
/4

End of Section A
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MR

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External Assessment 2024

ELECTRONICS & ADVANCED TECHNOLOGIES

EAT315124

Section **B**

Pages: 11
Questions: 5

Suggested working time: 36 minutes

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| Marker use | |
|------------|------|
| C5 | / 36 |

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EXEMPLAR

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Criterion/Criteria

You **must** make sure your answers address:

- Criterion 5 explain and apply mathematical concepts and scientific inquiry in relation to electronics.

Question 7

Marker use

Explain how you would demonstrate Kirchoffs current law (sum of all currents into a node is 0A). In your explanation include: components list, a circuit diagram, what measurements you take and how, and what you would expect to see.

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EXEMPLAR

Total
Q7
/6

Question 8

Marker use

You are designing an electronic cricket. It makes chirping sounds when the room is dark and quiet.

- a) Using the blocks in Table 8, draw the Input-Processor-Output function block diagram for this circuit.

/4

| Functional block | Description |
|---------------------|---|
| Light sensor | Outputs a voltage based on light level. Higher voltages correspond to darker conditions. |
| Microphone | Outputs a voltage based on sound level. Higher voltage corresponds to louder sounds. |
| Chirping subcircuit | Produces electronic pulses in the audio range of frequencies. |
| Buffer | Provides a boost in signal power. |
| Speaker | Makes sound when current is pulsed through it. |
| Logic subcircuit | Signals the chirping circuit to operate. |

Table 8

- b) Why would the buffer circuit be needed?

/1

.....

Question 8 continues

Question 8 continued

Marker use

c) The chirping subcircuit requires a logic high to active (make a sound).

In Table 9, write each of the input conditions with its corresponding output logic level and write the chirping subcircuit's corresponding input level. Use the completed table to draw the logic subcircuits diagram.

/3

| Light sensor output logic | Microphone output logic | Chirping subcircuit input signal logic |
|---------------------------|-------------------------|--|
| 0 | 0 | |
| 0 | 1 | |
| 1 | 0 | |
| 1 | 1 | |

Table 9

d) A friend suggested that your circuit may not work as intended, immediately stopping itself from working when it makes a sound. Describe what would be causing this suggested issue.

/2

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e) What might you add to the circuit that would allow it to make a sound for a few seconds? Carefully explain how it would work.

/2

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Total Q8
/12

Question 9

Marker use

A simple transistor circuit is shown in Figure 18. Transistor Q1 has a DC current gain (hFE) of 110.

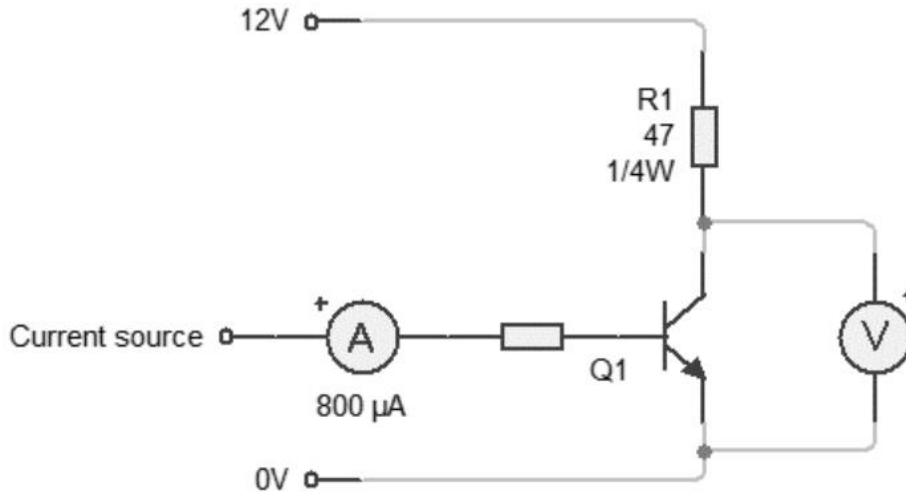


Figure 18: Diagram of a simple transistor circuit.

- a) Show that the current through the resistor R1 is about 90 mA.

/1

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- b) Calculate the voltage across the resistor R1.

/1

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- c) Calculate what the voltmeter reading would show.

/1

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- d) Calculate the power dissipated by the transistor.

/1

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- e) Is the 47Ω $\frac{1}{4}$ W resistor as shown suitable for R1? Justify your answer with a calculation.

/2

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Total
Q9
/6

Question 10 continued

Marker use

- e) Which single E12 resistor could replace R1 and R2 without significantly changed the output voltage?

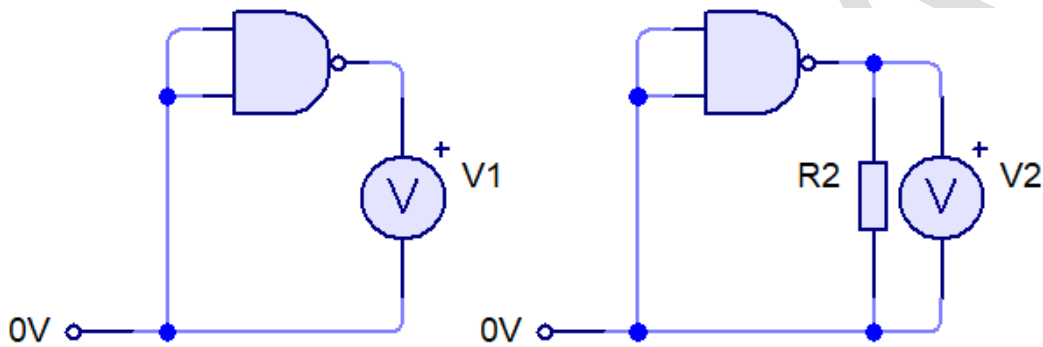
/2

Total
Q10

/8

Question 11

You are testing a logic gate to find its Thevenin equivalent circuit. The circuit was tested in two ways, show below.



The results of your tests are:

V1 is 5.0V

R2 is 1.0k Ω

V2 is 3.15V

- a) For the circuit containing R2, redraw the circuit as a voltage divider showing R_{Th}.

/1

Question 11 continues

Question 11 continued

Marker use

b) Draw the Thevenin equivalent circuit of the CD4011.

/1

c) Using the voltage divider formula, or otherwise find R_{Th} .

/2

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Total
Q11
/4

End of Section B
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ELECTRONICS & ADVANCED TECHNOLOGIES

EAT315124

Section C

Pages: 13
Questions: 4

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| Marker use | |
|------------|------|
| C6 | / 36 |

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EXEMPLAR

Guide to Exam Structure

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| Section C | 4 | 4 | 36 minutes | 36 marks |
| Section D | 5 | 5 | 36 minutes | 36 marks |
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Criterion/Criteria

You **must** make sure your answers address:

- Criterion 6 analyse and apply concepts and principles relating to discrete components and analogue circuits.

Question 12

Marker use

a) Complete Table 4 for resistor colour codes. The first row has been completed for you.

| Colour code | Nominal value | Minimum resistance |
|--------------------------|---------------|--------------------|
| brown black brown gold | 100 Ω | 95 Ω |
| red violet yellow silver | | |
| | 2200 Ω | 2156 Ω |
| green blue black brown | | 55R44 |

Table 4

/3

b) Complete Table 5 for capacitor values and codes.

| pF code | picofarads (pF) | nanofarads (nF) | microfarads (μ F) |
|---------|-----------------|-----------------|------------------------|
| 222 | | | |
| | | | 0.47 |

Table 5

/4

c) There are two (2) types of transistor within each technology. For bipolar transistors (eg BC547) name the two (2) types, draw their symbols, and explain how their behaviours are similar and how they differ.

/4

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Question 12 continues

Question 12 continued

Marker use

d) Draw the component symbols for each of the following:

i. Resistor

ii. Electrolytic capacitor

iii. Diode

iv. LED

v. Battery

vi. Potentiometer

/6

Total
Q12
/17

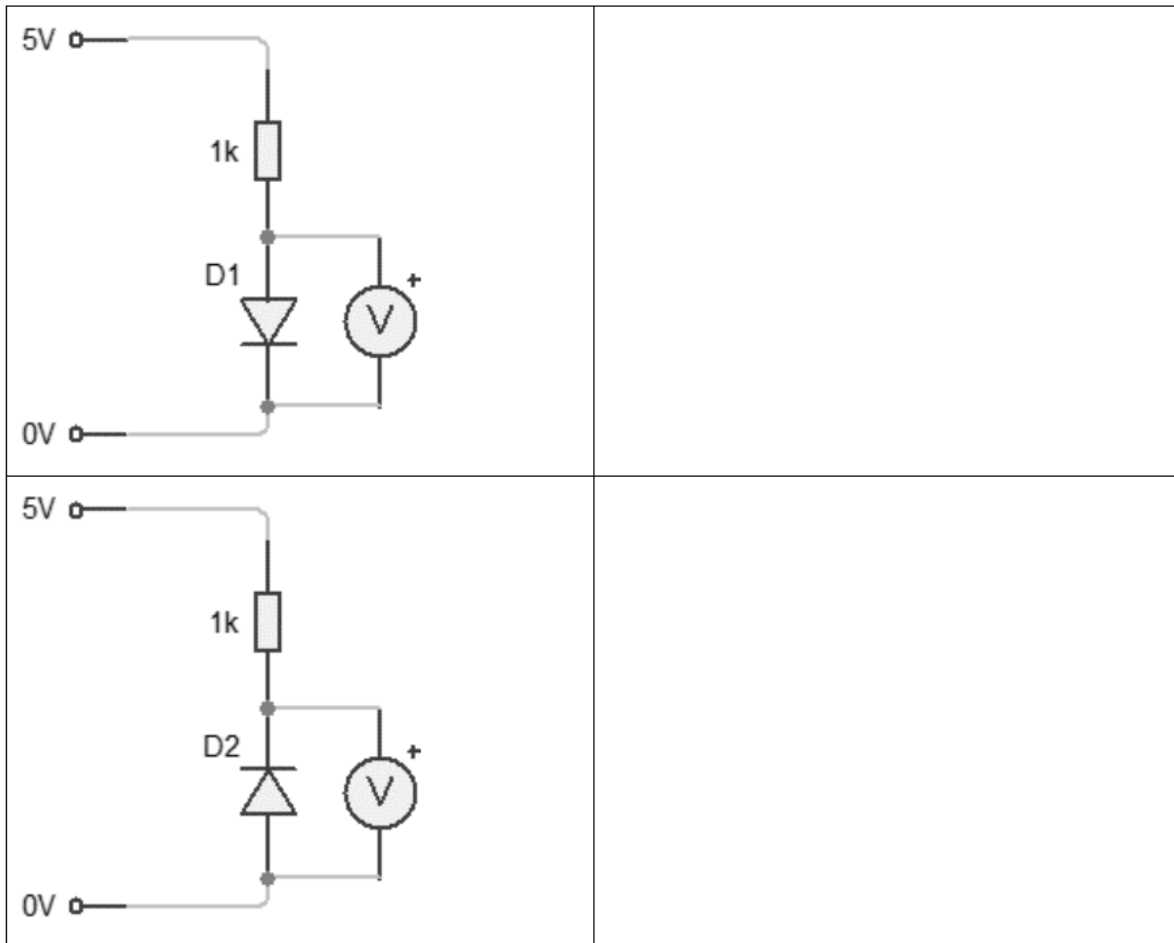
Question 13

Marker use

- a) State the approximate voltage you would expect on the meter in each of these circuits below.

/2

Note: each diode is a typical silicon diode (e.g. 1N4001)



- b) What would the approximate voltage reading be if D1 was replaced with a typical red LED?

/1

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Total
Q13

/3

Question 14

Marker use

For figure 12 (Circuit 3) shown

Note: Assume the switch has been open for a long time, and the circuit has a time constant of 1 second.

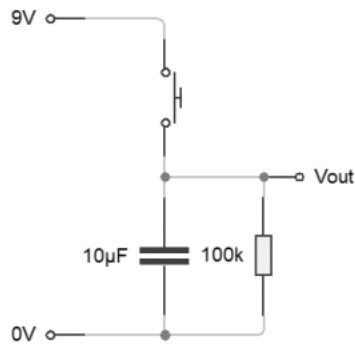
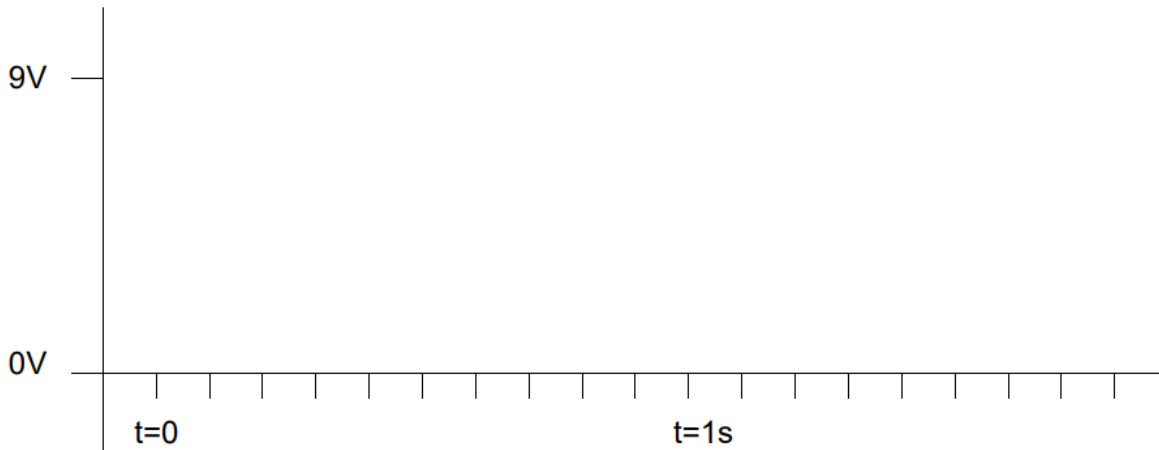


Figure 12: Diagram of Circuit 3.

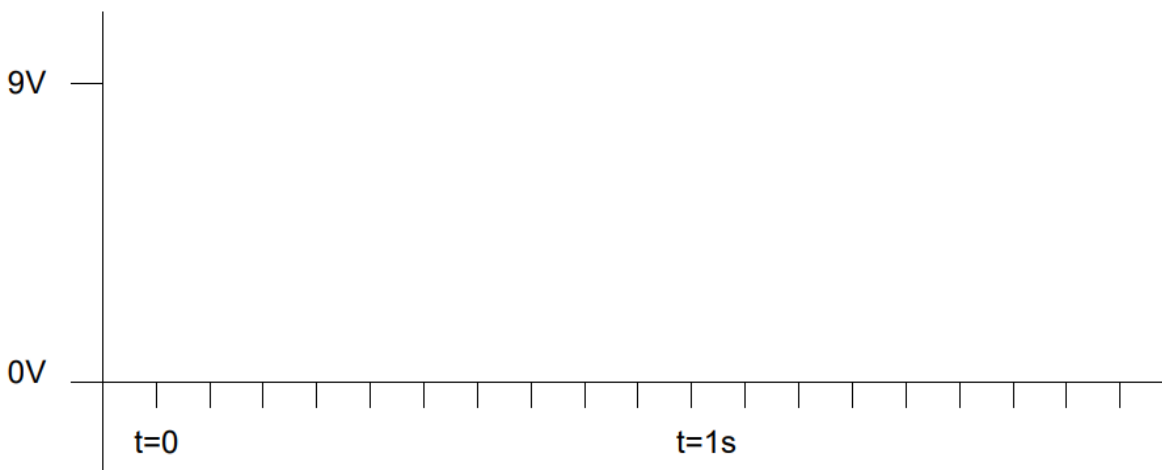
- a) Sketch the voltage over time at Vout when at t=0 the switch is closed for 0.1 seconds then opened again.

/2



- b) If you add another 10µF capacitor in parallel to the existing capacitor, explain what effect this has on the total capacitance, and sketch below the new voltage over time.

/2



Question 14 continues

Question 14 continued

Marker use

- c) Carefully describe an example where the above circuit could be used. Include any other relevant components that may be needed to perform it's function.

/2

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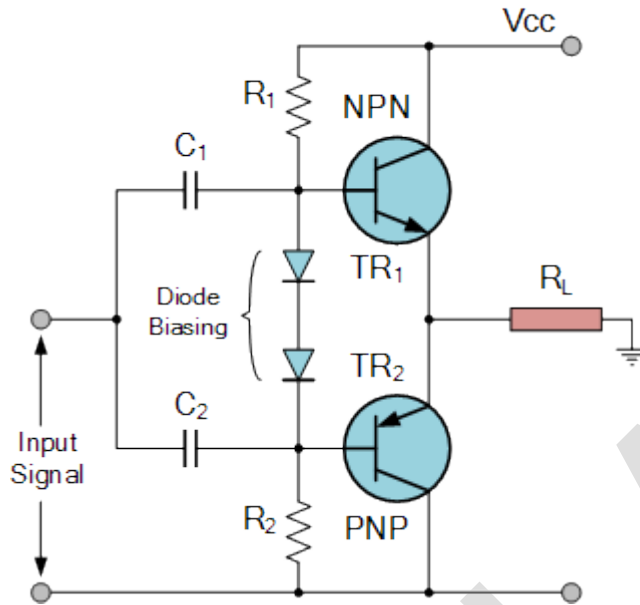
EXEMPLAR

**Total
Q14
/6**

Question 15

Marker use

The diagram below shows a simple class B transistor amplifier.



- a) Explain why the diode biasing is required. Include in your explanation what you would see without any biasing. You may wish to sketch what an oscilloscope would show when measuring voltage across R_L .

/2

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Question 15 continues

Question 15 continued

Marker use

b) Another way to bias the transistor is resistor biasing. Draw a diagram showing this, and explain how it is similar, and how it is different. No component values are necessary.

/1

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Consider the following function block diagram for an audio system project, containing the above circuit as one of the processors.



c) explain why the Audio signal going straight to the Class B amplifier will not be a suitable solution for this project.

/3

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d) Add to the above diagram a suitable processor block that would allow this project to function properly.

/2

Question 15 continued

Marker use

- e) Identify, and sketch below an appropriate discrete component solution for your selected processor block.

/2

EXEMPLAR

Total
Q15
/10

End of Section C
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EXEMPLAR

12

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ELECTRONICS & ADVANCED TECHNOLOGIES

EAT315124

Section **D**

Pages: 12
Questions: 5

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| Marker use | |
|------------|-----|
| C7 | /36 |

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EXEMPLAR

Guide to Exam Structure

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|------------------|---------------------|---------------------|----------------------------------|------------------|
| Section A | 6 | 6 | 36 minutes | 36 marks |
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Criterion/Criteria

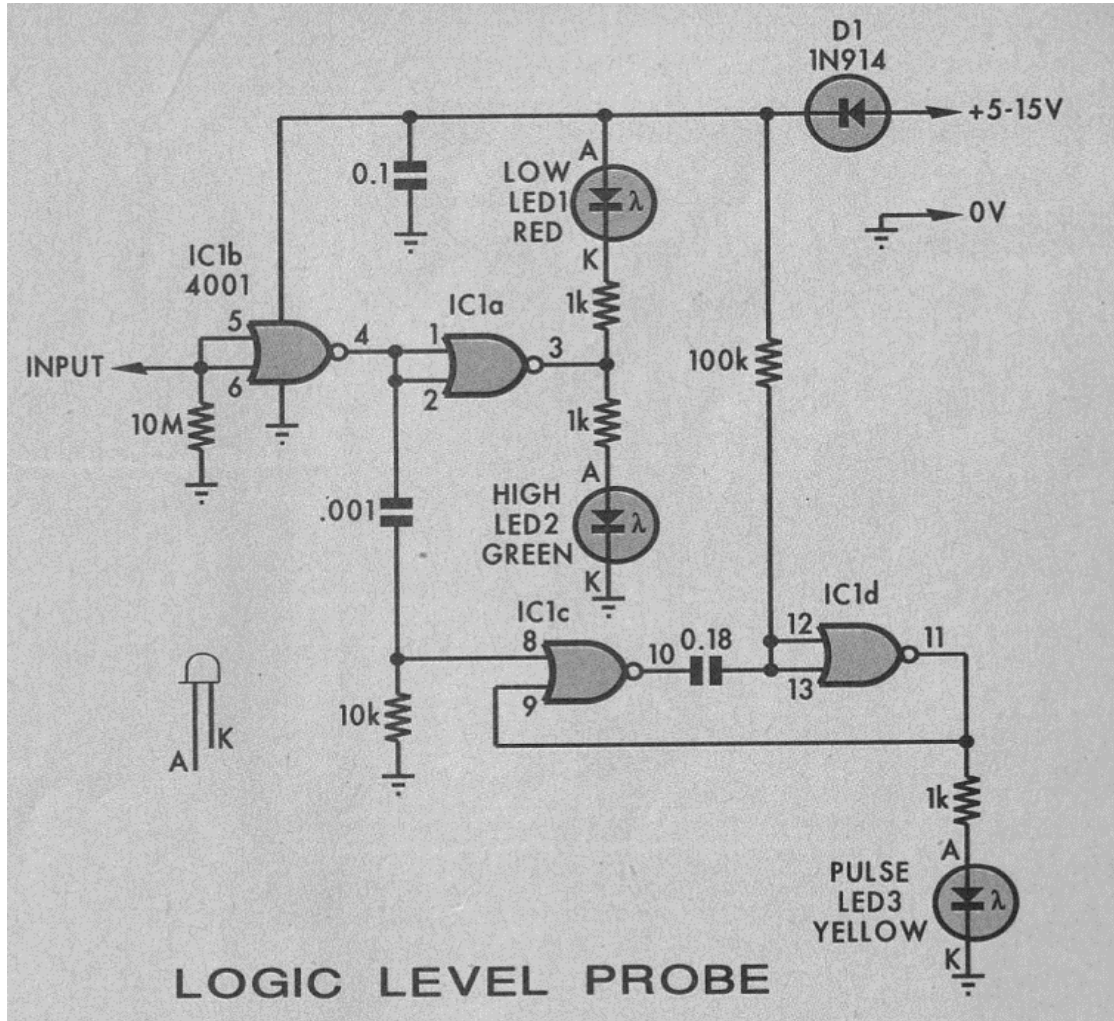
You **must** make sure your answers address:

- Criterion 7 analyse and apply concepts and principles relating to integrated circuits.

Question 15

Marker use

The schematic in Figure 6 is for a logic probe. It has three (3) LEDs that light up when the input is either: logic high, logic low, or pushing between the two (2).



a) Describe completely IC1.

/2

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b) What is the purpose of the 10M resistor connected to INPUT? What might happen if this were not included?

/2

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Question 15 continues

Question 15 continued

Marker use

- c) IC1a, b and d have both inputs of each gate connected. What other types of logic gate could replace these?

/1

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.....

- d) What voltage would you expect at pin 4 of IC1b for LED2 (green LED) to light up? Explain how you arrived at your answer.

/2

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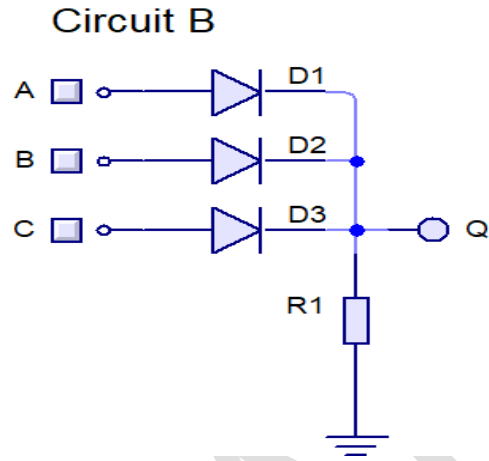
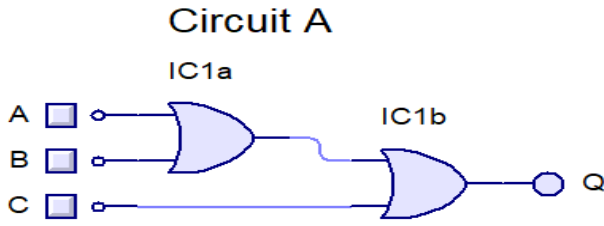
EXEMPLAR

**Total
Q15
/7**

Question 16

Marker use

Two (2) ways of performing a logical OR with three inputs is shown below.



a) State one (1) advantage of using circuit B instead of circuit A in a project.

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.....

/1

b) Using an example, carefully explain why circuit B is not always the solution when a 3 input OR gate is needed?

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.....
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/2

c) What (if any) are the differences between the voltages on the output (Q) of circuit A and circuit B? (assume all power supply and signal voltages are the same).

.....
.....

/1

Question 16 continues

Question 16 continued

Marker use

- d) Signal C is from a momentary switch (button). C is high when the button is pressed. Sketch the circuit diagram of the input subsystem that provides signal C. Include any components that address the limitations of this type of input. Provide explanation for their inclusion and what would happen if not included.

/4

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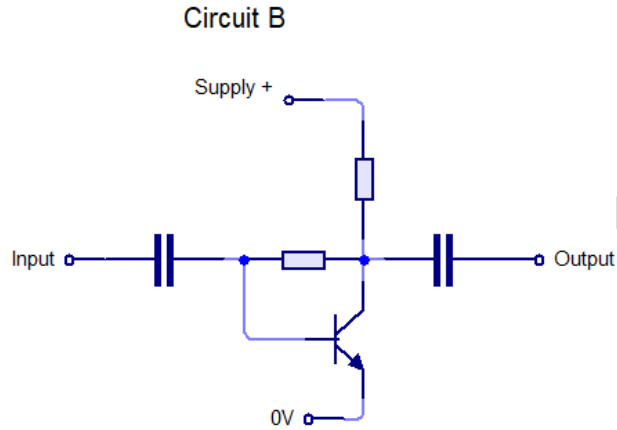
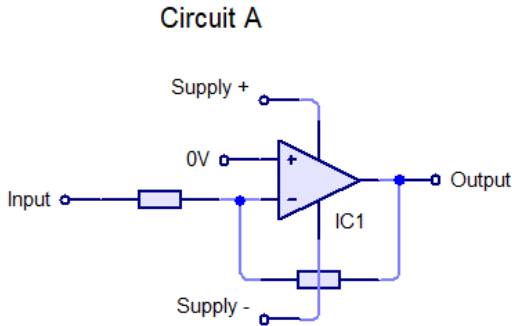
Total
Q16
/8

Question 17

Marker use

You are designing an audio amplifier system, and one of your functional blocks requires a pre-amplifier with a voltage gain of 150.

You look through your logbook and find the following two (2) circuits that could perform the function.



a) Describe the differences in these circuits on achieving the desired gain. Include in your answer how you could achieve the desired gain in each circuit.

/4

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b) Noting the power supply differences. Describe the limitations on choosing circuit A as shown. Name the circuit that is a solution to this.

/2

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c) Neither of these circuits is suitable for a power amplifier. Explain why.

/2

Circuit A:

.....

Circuit B:

.....

Total
Q17
/8

Question 18

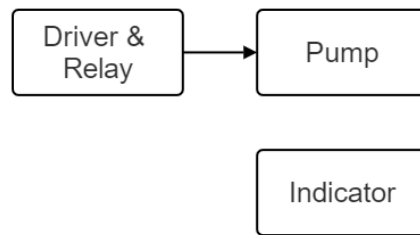
Marker use

Part of the specification for a central heating control system is shown below.

- A control timer produces a logic 1 to activate the system.
- The required room temperature is set using the set-temperature control potentiometer.
- The room temperature is sensed using an analogue temperature sensor.
- When the room temperature is below that required, the mains-powered pump is switched on to circulate hot water through the radiator in the room.
- An LED on the control panel is lit when the pump is on.

a) Add the necessary input, and processor blocks to complete the function block diagram below for the system.

/5



b) Which of your blocks converts analogue signals to digital signals?

/1

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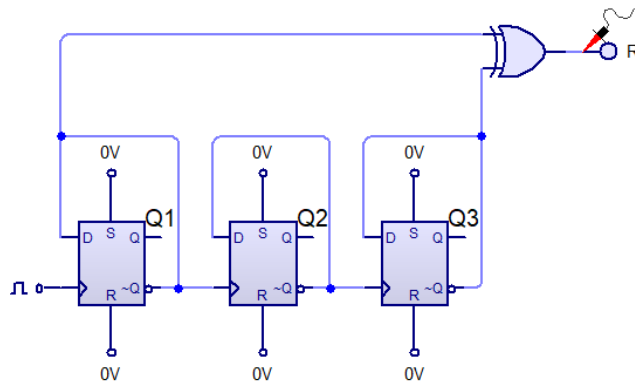
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**Total
Q18
/6**

Question 19

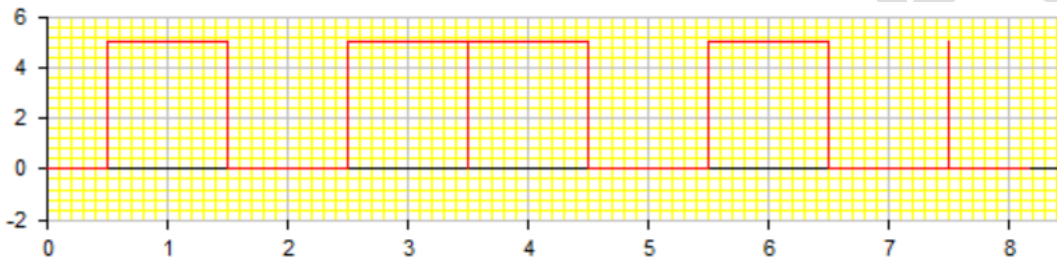
Marker use

The following circuit was designed to give a specific pattern of high and low outputs.



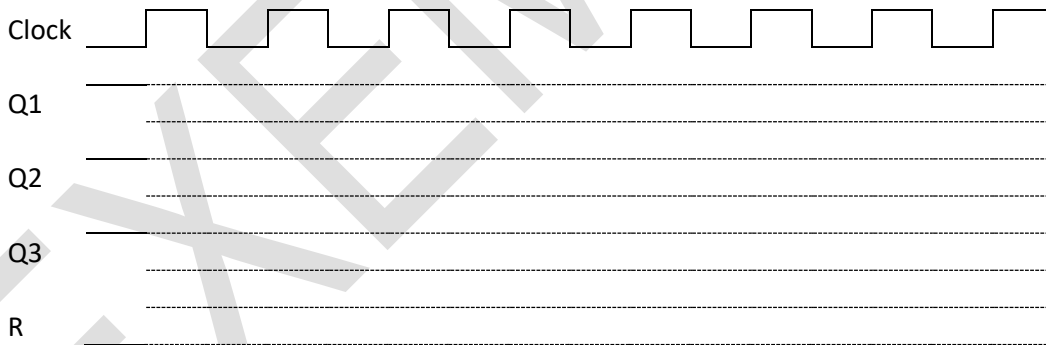
At some initial time, all Q outputs are logic “0”.

The Output waveform for R is shown below for the first 8 full clock cycles.



a) Using your knowledge of the logic circuit components shown, complete the timing diagram below.

/4



b) At time 3.5 and 7.5 the output waveform should look different than your timing diagram. Explain why these differences occur.

/3

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Total
Q19
/7

End of Section D

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EXEMPLAR

12

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EAT315124

Section **E**

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| Marker use | |
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| C8 | / 36 |

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Criterion/Criteria

You **must** make sure your answers address:

- Criterion 8 analyse and apply concepts and principles relating to programmable circuits.

Question 20

Marker use

Below is a code block for an Arduino using an ultrasonic sensor and LCD to display the distance detected by the sensor.

```
on start
  on LCD 1
    turn on the backlight

forever
  set cm to read ultrasonic distance sensor on trigger pin 7 echo pin 6 in units cm
  on LCD 1
    clear the screen
  set position on LCD 1 to column 0 row 0
  print to LCD 1 The distance is
  set position on LCD 1 to column 0 row 1
  print to LCD 1 cm
  print to LCD 1 cm
  wait 10 milliseconds
```

a) What pins are the ultrasonic sensor using?

.....

.....

/2

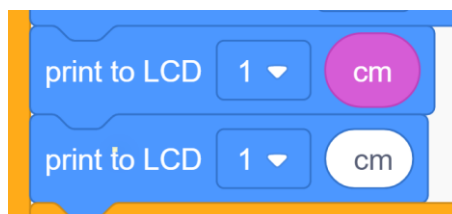
b) What happens exactly once per system start-up?

.....

.....

/1

c) What is the difference between the two commands shown below?



.....

.....

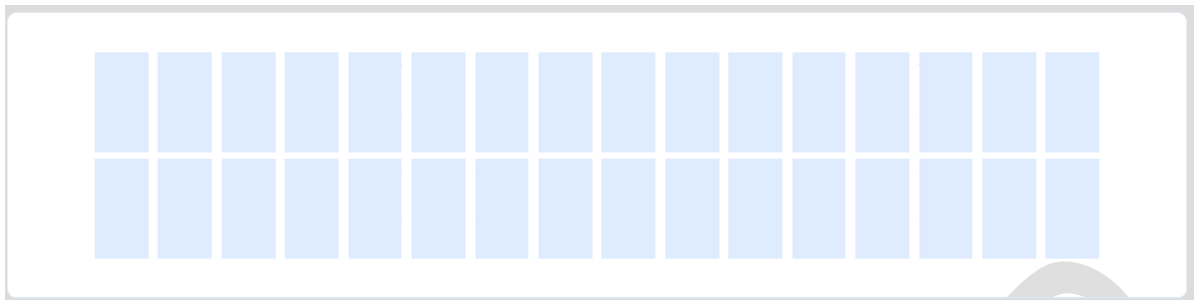
/1

Question 20 continues

Question 20 continued

Marker use

d) Draw on the diagram below what the output would look like if the distance were 45cm.



/2

e) What is the purpose of the wait command?

/1

.....

.....

.....

f) Why is some of the program in the “forever” loop, and other rest in the “on start” loop? In your answer, explain why loops are necessary.

/3

.....

.....

.....

EXAMPLE

Total
Q20
/10

Question 21

Marker use

Explain and provide an example for the following benefits of microcontrollers or advanced technologies.

a) Reduced design complexity

/2

.....
.....

b) Reduced cost

/2

.....
.....

c) Increased reliability

/2

.....
.....

d) Increased design flexibility

/2

.....
.....

EXEMPLAR

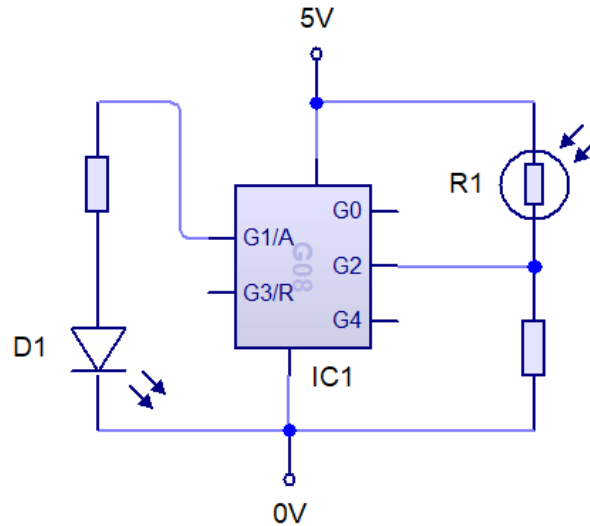
Total
Q21
/8

Question 22

Marker use

The diagram below is for a light level indicator using a microcontroller.

- R1 is a light dependant resistor, which in this configuration will output a high voltage in bright light, and low voltage in dark.
- IC1 is a microcontroller with analogue input on G2, and digital output on G1.



a) Using whichever programming language/structure you choose, write a program on the next page that meets the following specifications:

- Reads the light level.
- Turns the LED off when the light level goes above 500.
- Turns the LED on when the light level goes below 400.
- Defaults to LED off on start.

Your program should be suitably commented.

/5

Question 22 continues

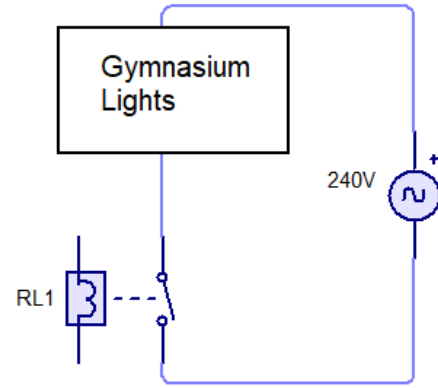
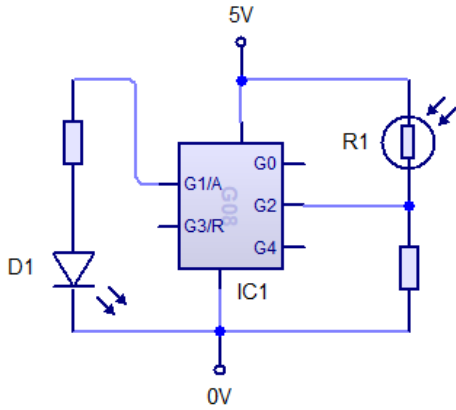
EXEMPLAR

Question 22 continued

Marker use

- b) You plan to use this circuit to control the lights in a gymnasium. Using pin G4 of the microcontroller for the lights, modify the diagram in the space below, adding any necessary components and lines of code. Indicate where this code should be included in the program.

/3



.....

.....

.....

- c) Most use gymnasiums use special high-power lamps which need a delay time of 10 minutes after they are turned off before they can be turned back on.

/2

Explain how the above specifications only partly meet this requirement, and what you should add or change in the specifications to meet it.

.....

.....

.....

.....

Total
Q22
/10

Question 23

Marker use

I2C and W1 (one wire) are two communications protocols commonly used for controllers and sensors. They use a common bus to communicate with multiple devices connected

- Both protocols can be described as “half duplex”
- I2C is a “many-to-many” and W1 is “many-to-one”.
- I2C requires 2 wires + ground, and W1 requires 1 wire + ground.
- I2C is limited in communication wire length of 1 metre, and W1 can be much longer.
- I2C has fast data rates of up to 5.0 Mbit/s, and W1 has slower data rates of 16.3 kbit/s.

a) Explain what a “bus” is in the context of electronics communications.

.....
.....

/1

b) Explain what is meant by the term “half duplex”. How does it differ from “full duplex”?

.....
.....

/2

c) What protocol would be best suited for measuring 20 temperature sensors located around a building? Justify your answer.

.....
.....

/2

**Total
Q23
/5**

Question 24

Marker use

Open-source libraries are often used when programming.

a) Explain what a “library” is in the context of programming? How are they useful?

/2

.....
.....

b) What is meant by the term “open-source”?

/1

.....
.....

EXEMPLAR

**Total
Q24
/3**

End of Exam

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EXEMPLAR

12

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