TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2024

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ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section A

Pages: 12
Questions: 6
Information Sheet: 1

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.
- Spare diagrams have been provided at the end of this section. Indicate in the box provided if you have used the spare diagram.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- The Electronics and Advanced Technologies Information Sheet can be used throughout the exam.
- TASC approved scientific calculators can be used throughout the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C3	/ 36

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	6	6	36 minutes	36 marks
Section D	5	5	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**27**	**27**	**180 minutes (3 hours)**	**180 marks**

Criterion

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) The 3A fuse for a television needs replacing. However, the technician only has 2.5A and 5A fuses available. Explain which of these fuses they might select as a replacement. /2

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b) Time-delay fuses are able to be overloaded for a short period of time. Describe a context where it would be appropriate to use a time-delay fuse. /2

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c) A residual current device is often connected to circuits in environments that have damp conditions where appliances – such as hair dryers – may be used. Explain the electrical hazard present in these environments and how the residual current device works to reduce potential harm. /2

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Total Q1 /6

Question 2

Marker use

Explain why each of the following may be risks for an electronics student:

a) Capacitors

..... /1

.....

b) Solder

..... /1

.....

Total Q2 /2

Question 3

Marker use

Design and draw the schematic diagram for:

a) A battery connected to an LED that uses two resistors in parallel to limit the current. The values of the resistors are not required.

/2

b) An Op-Amp with a gain of -3 is connected to a 12V dual power supply. Give possible values of any resistors used, and label where any inputs and outputs should be connected.

/3

Total Q3

/5

Question 4

Marker use

Figure 1 is a circuit schematic being used to monitor water levels for a water tank.

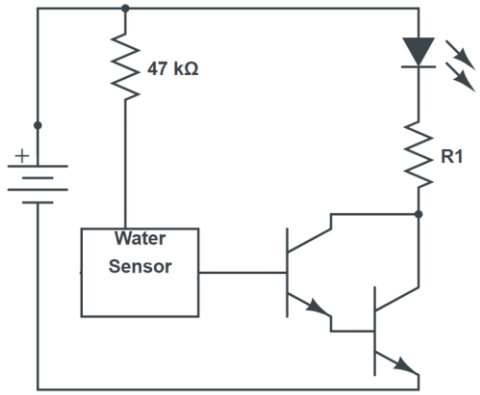

Figure 1: Circuit schematic to monitor water levels.

Spare diagram used (X) ☐

a) Using an appropriate symbol, show where you would connect each of the following to Figure 1:

i. A voltmeter to measure the voltage being supplied by the battery. /1

ii. An ammeter to measure the current running into the base of the principal transistor of the Darlington pair. /1

b) Represent the circuit in Figure 1 as a simple IPO function block diagram. /2

c) Why might it be useful to test the circuit in Figure 1 with both breadboarding the circuit and using simulation? /2

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Question 4 continues

Marker use

d) Compete the circuit using the breadboard in Figure 2, by referring to Figure 1 and filling in the missing wires.

/3

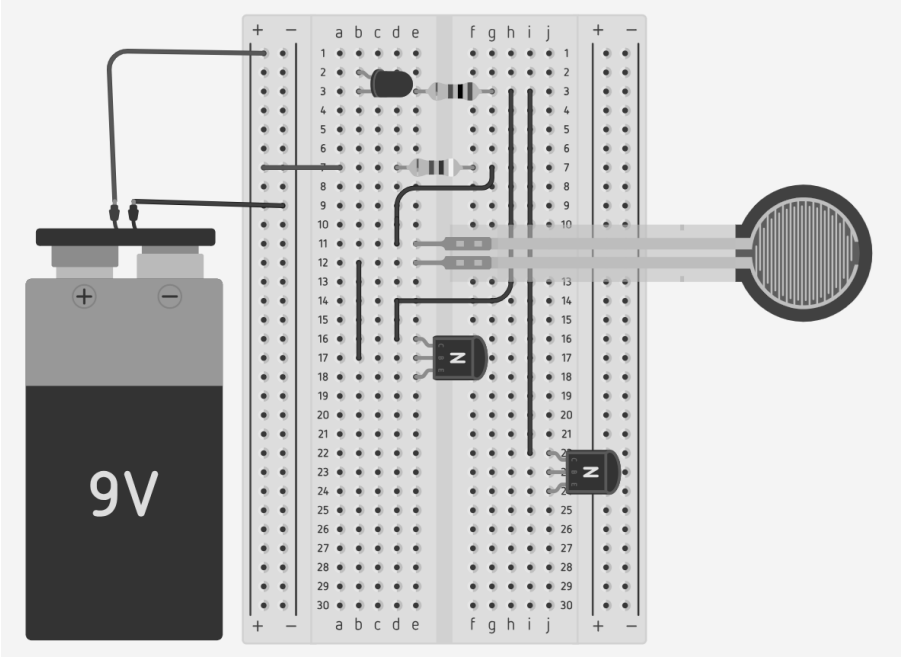

Figure 2: Breadboard of circuit to monitor water levels.

Spare diagram used (X) ☐

e) What considerations would be appropriate when determining the value of R1?

/2

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Total Q4

/11

Question 5

Marker use

Figure 3 shows the output signal of an amplifier circuit when it is connected to a given input signal.

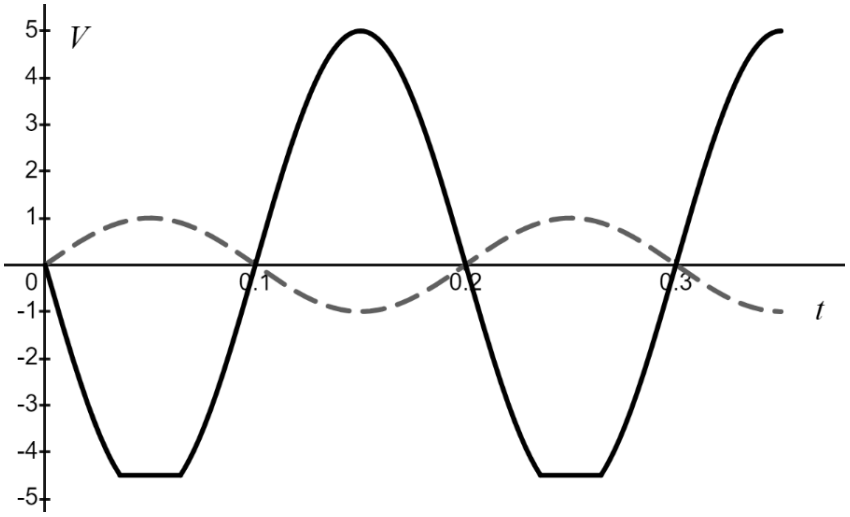

Figure 3: Input/output signals for an amplifier circuit.

a) Name a piece of equipment that displays Figure 3.

.....

/1

b) Name the piece of equipment that may have been used to provide the input signal in Figure 3. Then, describe the input signal in terms of its shape, peak-to-peak voltage, and frequency.

/4

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c) State the type of distortion shown in Figure 3, and detail a possible way in which the amplifier circuit might be adjusted so that the distortion is removed.

/2

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Total Q5

/7

Question 6

Marker use

Figure 4 is a design for a PCB which uses an integrated circuit chip to create an OR gate.

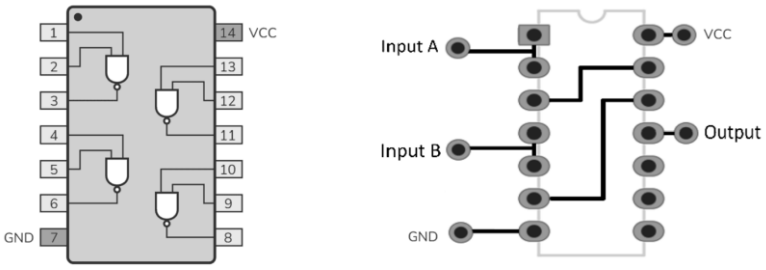

Figure 4: Integrated circuit chip and OR gate design.

a) What is the integrated circuit chip in Figure 4 called?

.....

/1

b) The integrated circuit chip uses complementary metal-oxide-semiconductor (CMOS) logic. Circle the correct statement below for handling CMOS chips:

/1

i. The voltage source must be exactly 6V to operate due to the limited power supply operation range.

ii. Static discharge on the input pins should be avoided due to their high input impedance.

iii. Changes to the input voltage should be done slowly to ensure the slew rate is not exceeded.

iv. The pins are very sturdy and should be bent to make them more malleable for breadboarding with.

c) Explain how the track between pin 3 and pin 13 on the PCB can be tested to ensure conductivity.

/1

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d) Use the information in Figure 4 to complete the following circuit diagram.

/2

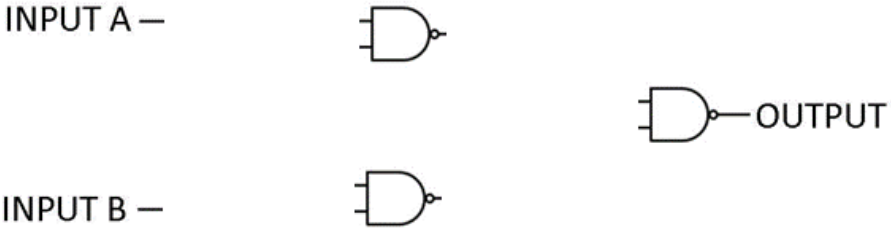


Figure 5: Circuit diagram to sketch your answer to Question 6 d).

Spare diagram used (X) ☐

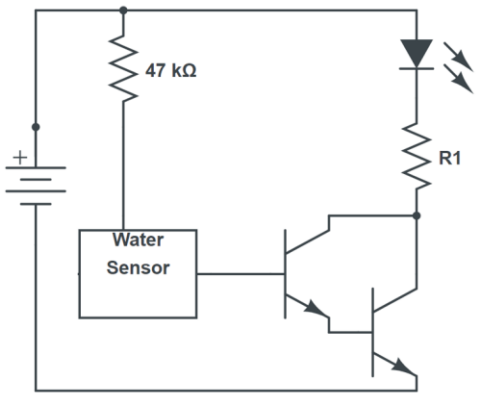
Total Q6

/5

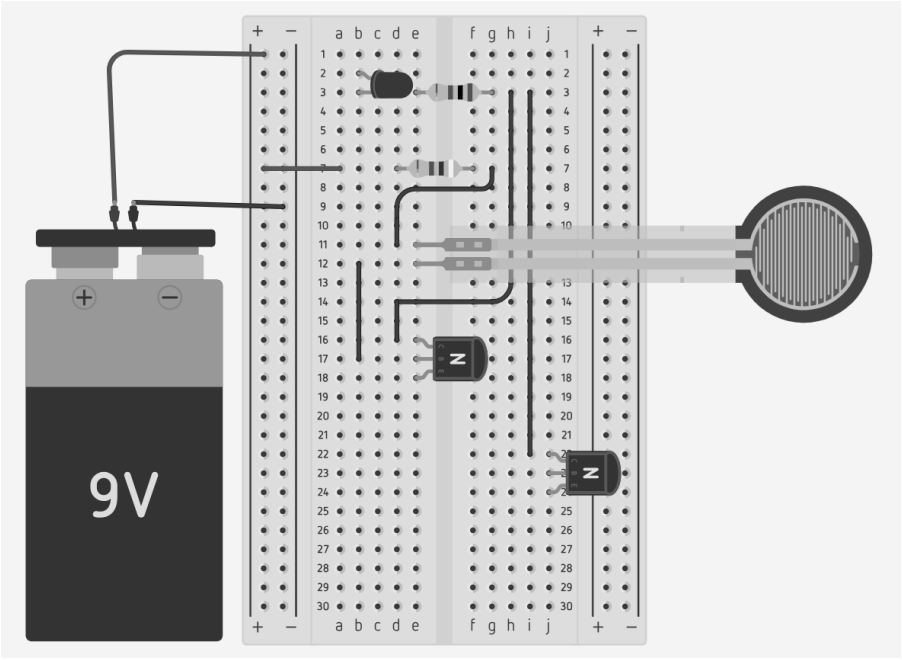
Spare Diagrams

Marker use

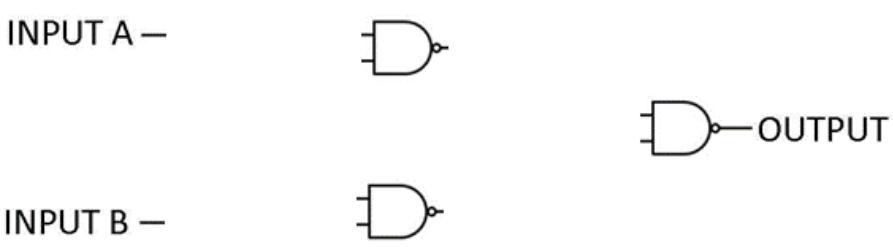
Question 4 a)



Question 4 d)



Question 6 d)



End of Section A

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ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section B

Pages: 12
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

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Marker use	
C5	/ 36

Guide to Exam Structure

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Criterion

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

Figure 6 is a resistor network.

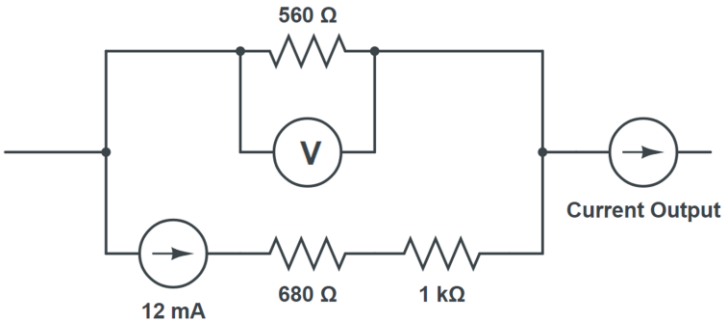

Figure 6: Circuit diagram of a resistor network.

a) Calculate the total equivalent resistance of Figure 6.

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.....

/3

b) Use Ohm's Law and Kirchhoff's Voltage Law to determine the voltmeter reading.

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/2

c) Show that the current output is approximately 48 mA, by using Kirchhoff's Current Law.

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/2

Total Q7

/7

Question 8

Marker use

The transistor in Figure 7 has a DC current gain (hFe or β) of 25.

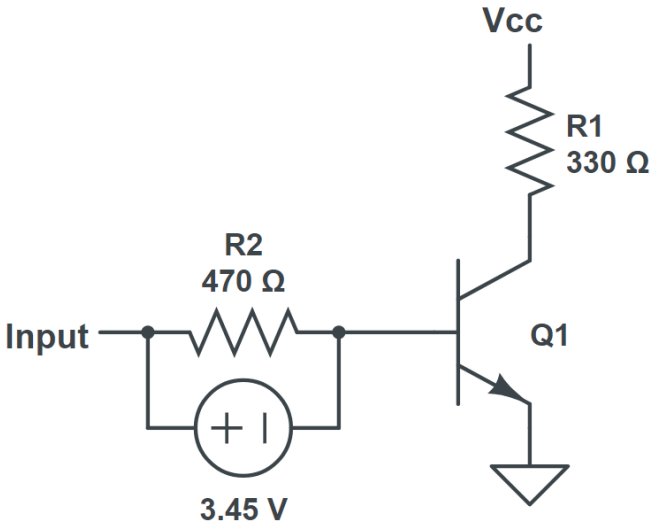

Figure 7: Circuit diagram of a transistor amplifier.

a) Show that the current flowing through R2 is approximately 7mA.

.....

.....

/1

b) Hence, calculate the current flowing through R1, assuming Q1 is unsaturated.

.....

.....

/1

c) Use an appropriate calculation to determine if R2 would overheat a **quarter watt** resistor.

.....

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.....

.....

/2

Total Q8

/4

Question 9

Marker use

The circuit inside the box shown in Figure 8 is a linear circuit, made of voltage sources, current sources, and resistors.

Figure 8: Diagram of a mystery linear circuit.

a) Outline how you would determine the Thevenin Equivalent circuit, making sure to include the names of any components or tools that you would use, circuit diagrams that show what measurements you would take, and formulae you would use.

/4

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b) Sketch the Thevenin Equivalent circuit.

/2

Total Q9

/6

Question 10

Marker use

The circuit in Figure 9 is for a time delay switch.

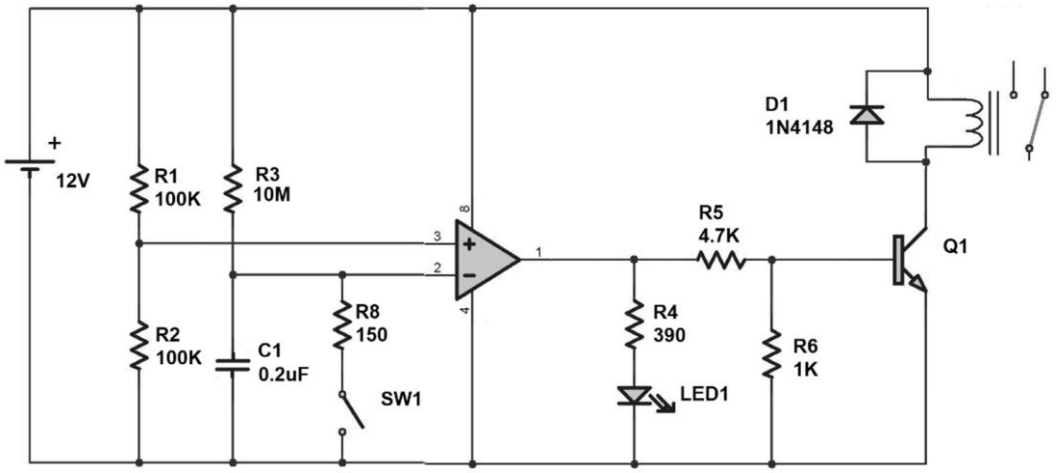

Figure 9: Circuit diagram of a time delay switch.

Spare diagram used (X) ☐

The circuit can be broken up into the following function blocks.

R1 and R2 form a voltage divider that sets the reference voltage of the Comparator.

a) Calculate the voltage at the non-inverting input.

..... /1

.....

C1, R3 and R8 form two different RC timing circuits that set the time delay of the switch.

b) Will the capacitor be charging or discharging when SW1 is closed?

..... /1

c) Calculate the time constant of C1 and R3.

..... /1

d) When the capacitor is fully charged, approximately how long will it take to discharge to its minimal voltage? /2

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.....

Question 10 continues

Marker use

The comparator will saturate **high** when the capacitor's charge is less than the reference voltage set by the voltage divider. This turns the indicator LED1 on.

e) What is the output voltage of the comparator when it saturates **high**?

..... /1

f) If the forward voltage of LED1 is 3V, calculate the current through R4.

..... /2

.....

This activates the relay-switch.

g) What is the purpose of D1?

..... /1

Rapid switching of the relay is referred to as relay chatter. This can be eliminated by adding a component to give the comparator **hysteresis**.

h) Add the component symbol to Figure 9. /2

i) Briefly outline the effect hysteresis has on the comparator.

..... /1

.....

j) Using the sub-circuits mentioned in the previous parts of this question, summarise the circuit in Figure 9 as an input-processor-output function block diagram. /4

Total Q10 /16

Question 11

Marker use

Figure 10 is a simple voltage regulator that utilises a Zener diode. The breakdown voltage of D1 when the current is above 70mA is approximately 5.6V.

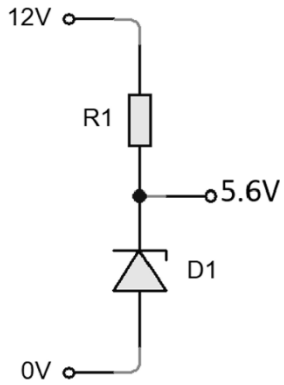

Figure 10: Circuit diagram of a voltage regulator.

a) Calculate the voltage across R1 when the current is above 70mA.

..... /1

b) Determine a suitable E12 resistor value for R1.

..... /2

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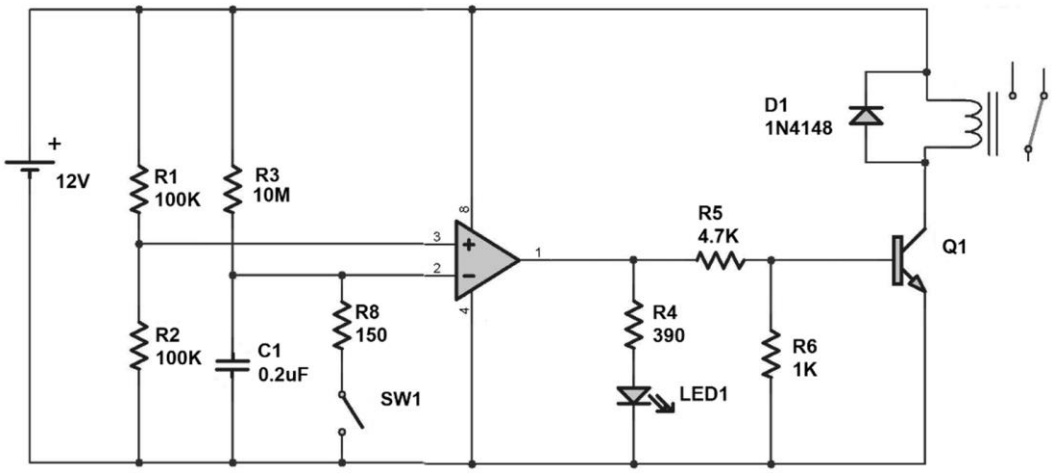
Total Q11 /3

Spare Diagram

Marker use

Question 10



End of Section B

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ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section C

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C6	/ 36

Guide to Exam Structure

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Totals	**27**	**27**	**180 minutes (3 hours)**	**180 marks**

Criterion

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 the rows in Table 1 with the corresponding capacitor codes and values.

/3

pF Code	picofarads (pF)	nanofarads (nF)	microfarads (uF)
223			
			0.15
		3n9	

Table 1

Spare diagram used (X) ☐

b) Three capacitors, 1.5µ, 220n and 470n are given. Arrange **two (2)** of these capacitors to give the:

/3

i. Maximum total capacitance

ii. Minimum total capacitance

Total Q12

/6

Question 13

Marker use

Sketch the circuit symbol for each of the following components:

/4

Light dependent resistor

Potentiometer

SPDT Switch

NPN Transistor

Total Q13

/4

Question 14

Marker use

Figure 11 is a transistor amplifier circuit.

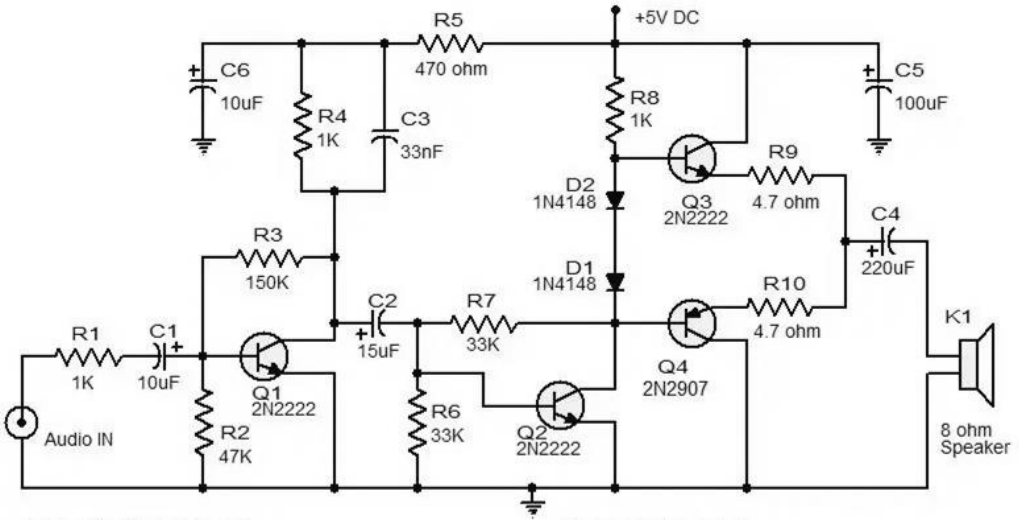

Figure 11: Circuit diagram of a transistor amplifier.

a) Name the component C5 and state its purpose.

..... /2

.....

b) Describe the role of C1.

..... /1

Q1 and its associated components are wired as a pre-amplifier circuit.

c) What is the purpose of a pre-amplifier circuit?

..... /1

d) Which component provides collector to base biasing for Q1? Why is it needed?

..... /2

.....

A transistor block is formed involving Q3 and Q4.

e) Give the common name of this transistor block and describe how it works, making sure to reference the role of components D1 and D2. /3

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.....

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Total Q14

..... /9

Question 15

Marker use

/4

Fill in Table 2 by giving approximate output voltage for each of the circuits shown:

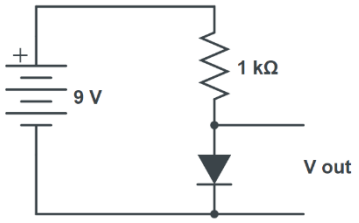
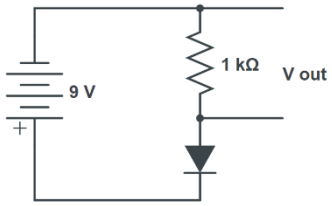
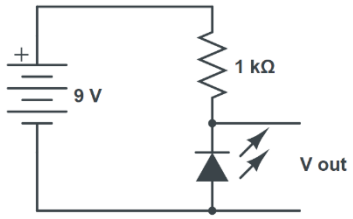
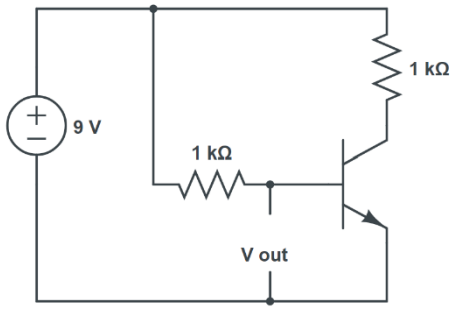
Circuit	Vout
	
	
	
	

Table 2

Spare diagram used (X) ☐

Total Q15

/4

Question 16

Marker use

Figure 12 is a circuit diagram of a half wave rectifier.

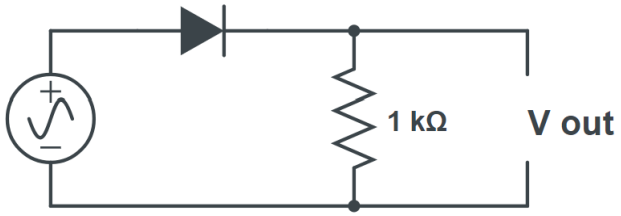


Figure 12: Circuit diagram for a half wave rectifier.

a) Complete the graph (Figure 13) showing the output voltage for the input voltage given.

/2

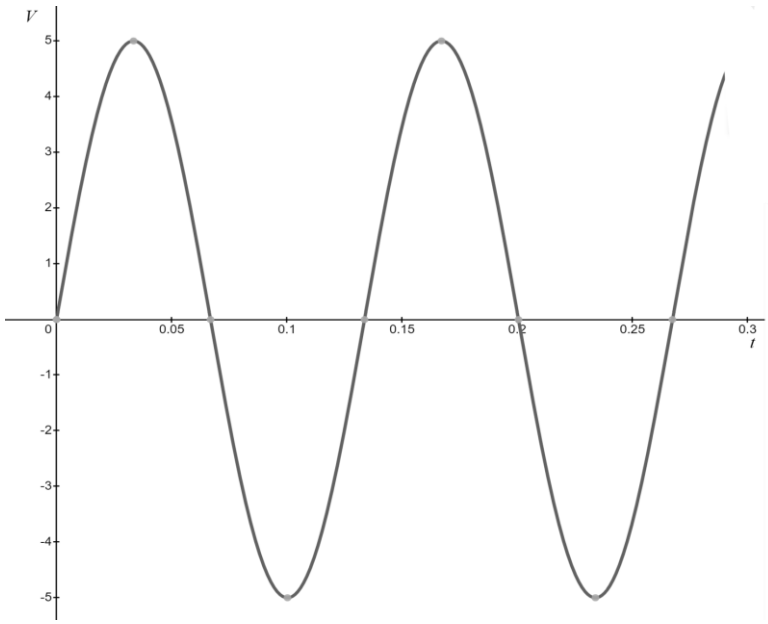


Figure 13: Input voltage for a half wave rectifier circuit.

Spare diagram used (X) ☐

b) Determine the RMS value of the input voltage.

/1

.....

Question 16 continues

Marker use

The circuit diagram can be expanded on to make a bridge rectifier that outputs full-wave rectified DC voltage as shown in Figure 14.

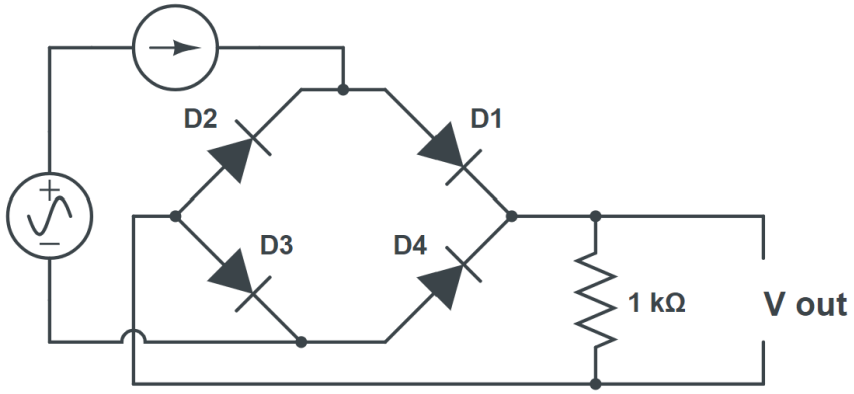


Figure 14: Circuit diagram of a bridge rectifier.

c) Explain what DC means.

.....

/1

d) Which diodes will have current flowing through them when the ammeter is showing a *negative* value?

/1

.....

e) A certain component can be used to smooth the output voltage. Add the necessary component to the circuit diagram in Figure 14.

/1

Total Q16

/6

Question 17

Marker use

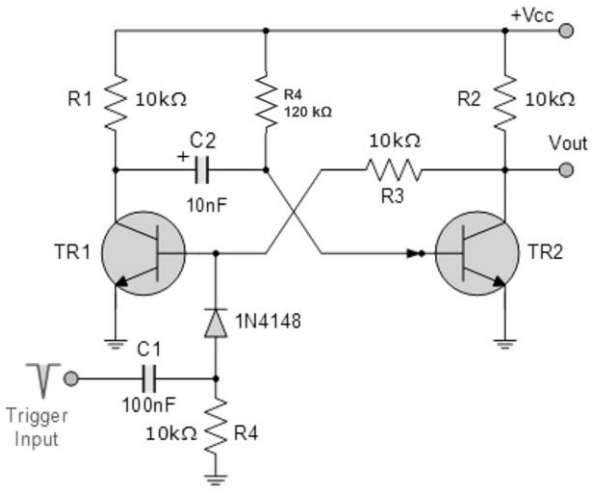


Figure 15: Circuit diagram

a) Name the circuit in Figure 15 and give an example of what it could be useful for.

/2

.....

.....

b) When Vcc is turned on, which transistor will be active?

/1

.....

c) Which components are responsible for determining the timing of Vout after the pulse has been fed in?

/1

.....

d) When the negative trigger input shown is applied to the circuit, describe what change will be seen at Vout.

/3

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.....

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Total Q17

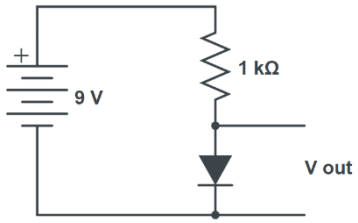
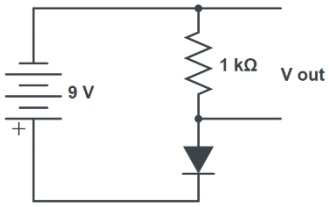
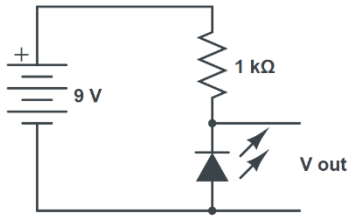
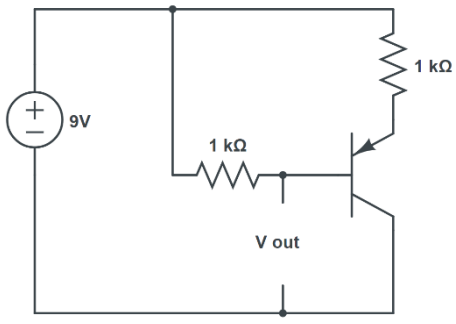
/7

Spare Diagram

Question 12 a)

pF Code	picofarads (pF)	nanofarads (nF)	microfarads (uF)
223			
			0.15
		3n9	

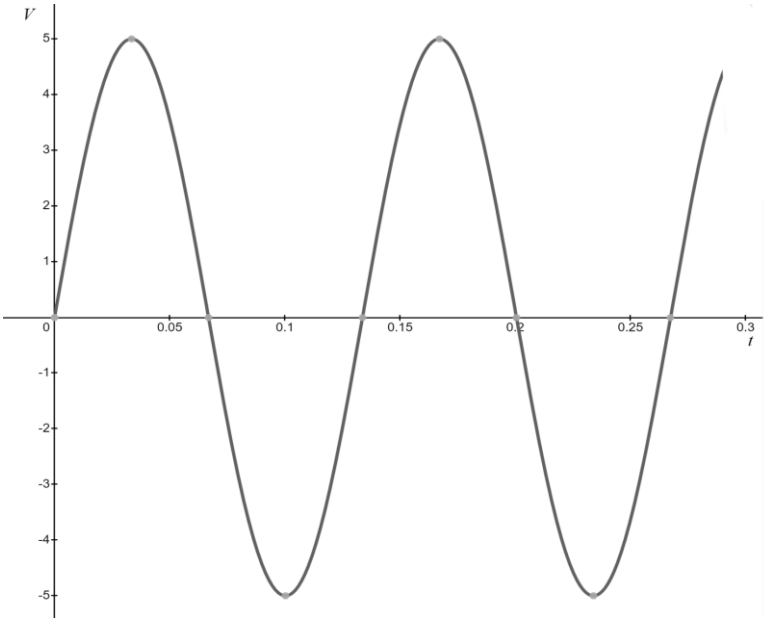
Question 15

Circuit	Vout
	
	
	
	

Spare diagrams continue

Spare diagrams continued

Question 16 a)



End of Section C

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ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section D

Pages: 12
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

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- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
- Spare diagrams have been provided at the end of this section. Indicate in the box provided if you have used the spare diagram.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- The Electronics and Advanced Technologies 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.

Marker use	
C7	/ 36

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	6	6	36 minutes	36 marks
Section D	5	5	36 minutes	36 marks
Section E	5	5	36 minutes	36 marks
Totals	**27**	**27**	**180 minutes (3 hours)**	**180 marks**

Criterion

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

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

Question 18

Marker use

Characteristics gathered from the data sheet of two operational amplifiers are shown in Table 3.

Characteristics	Op Amp 1	Op Amp 2	Units
Input Impedance	1	4	MΩ
Output Impedance	5	100	Ω
Max Supply Voltage	±30	±30	V
Output Voltage Swing	±25	±28	V
Slew Rate	0.2	4.5	V/μs
Open-loop Gain	100	10	dB
Unity Gain Bandwidth	0.5	5	MHz

Table 3

a) Name **two (2)** characteristics from Table 3 that make Op Amp 1 more ideal than Op Amp 2. /2

.....

.....

.....

b) Give an example of an application where it would be more appropriate to use Op Amp 2. /1

.....

.....

Often a discrete circuit involving a transistor is used for amplification rather than an integrated circuit such as an Operational Amplifier.

c) Explain **one (1)** advantage and **one (1)** disadvantage of using a discrete circuit rather than an integrated circuit. /2

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Total Q18 /5

Question 19

Marker use

Figure 16 is a counting circuit for determining the amount of airport luggage. A suitcase travelling between the **LED** and **phototransistor** interrupts the beam of light between the two components.

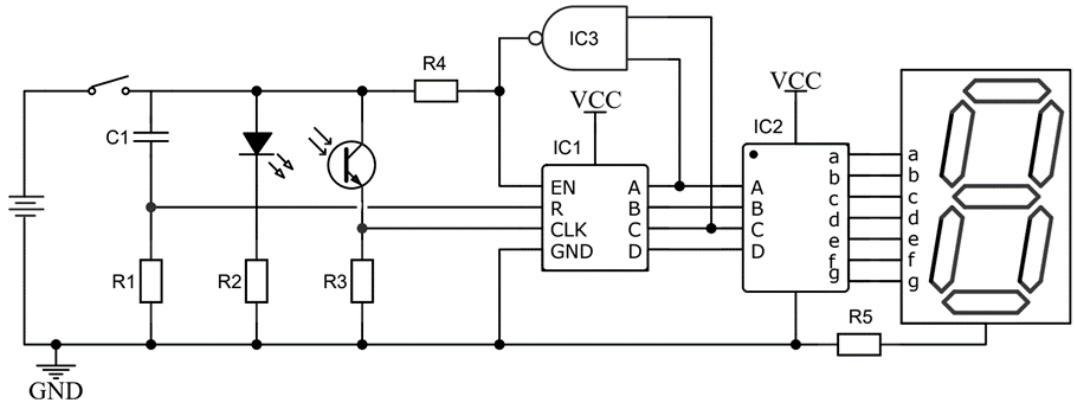


Figure 16: Circuit diagram for counting airport luggage.

a) When luggage is loaded for a new flight, the circuit is connected to the power supply by closing the switch. Explain the role of C1. /3

.....

.....

.....

b) When the phototransistor is activated by light, is the logic level at the clock of IC1 High or Low? /1

.....

c) Explain how switch bounce occurs with mechanical switches and why a phototransistor has been chosen instead. /2

.....

.....

.....

d) Is EN 'Active High' or 'Active Low'? Explain how you can tell. /2

.....

.....

Question 19 continues

Marker use

e) Complete the truth table (Table 4) to determine when EN changes state. /2

C	B	A	EN
0	0	0	
0	0	1	
1	1	1	

Table 4

Spare diagram used (X) ☐

You wish to change how many suitcases are counted before counting is paused.

f) Which outputs of IC1 should be connected to IC3 (in Figure 16) so that counting now pauses after 9 bags have been counted? /1

.....

g) Is the display common cathode or common anode? /1

.....

h) When the circuit operates, it is found that the brightness of the display varies depending on what number is showing. Why is this happening, and what adjustment to the circuit in Figure 16 would fix this? /2

.....

.....

.....

Total Q19 /14

Question 20

Marker use

Geese Lighting has asked for you to design a circuit which turns car headlights on manually or automatically. The headlights can be switched on manually by using a switch. They also turn on automatically when it is dark outside and the key detector senses the keys are in the ignition. When the headlights are manually switched on and the key is removed from the ignition, an alarm sounds. A Block Diagram of this circuit is shown in Figure 17.

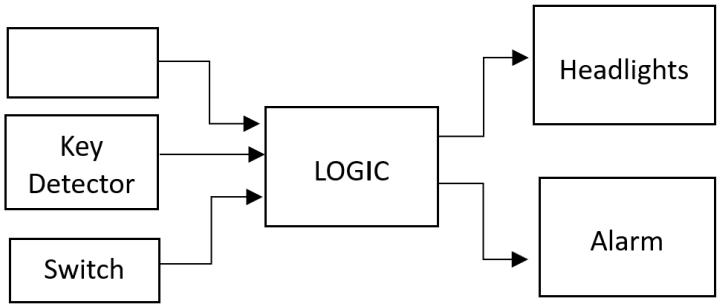


Figure 17: Block Diagram for a headlight circuit.

a) Detail an integrated circuit with associated components that you could use to fill in the blank box responsible for returning logic HIGH when it is dark outside. /2

.....

.....

.....

.....

b) Complete the truth table (Table 5). /2

Darkness (Dark = 1)	Keys (In Ignition = 1)	Switch (On = 1)	Headlights (On = 1)	Alarm (On = 1)
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Table 5

Spare diagram used (X) ☐

Question 21 continues

Marker use

c) Design a circuit using logic gates that would be appropriate for the ‘Logic’ block.

/4

Total Q20

/8

Question 21

Marker use

The four-bit binary ripple counter in Figure 18 is constructed using D-Type flip flops.

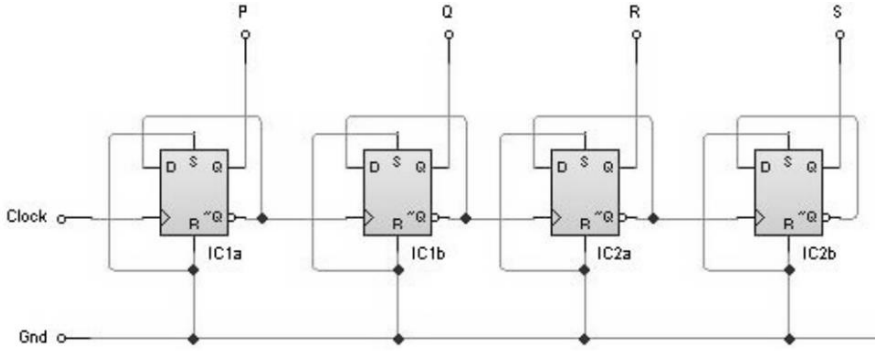


Figure 18: Circuit diagram of a four-bit binary ripple counter.

a) How many integrated circuit chips have been used to build this circuit?

..... /1

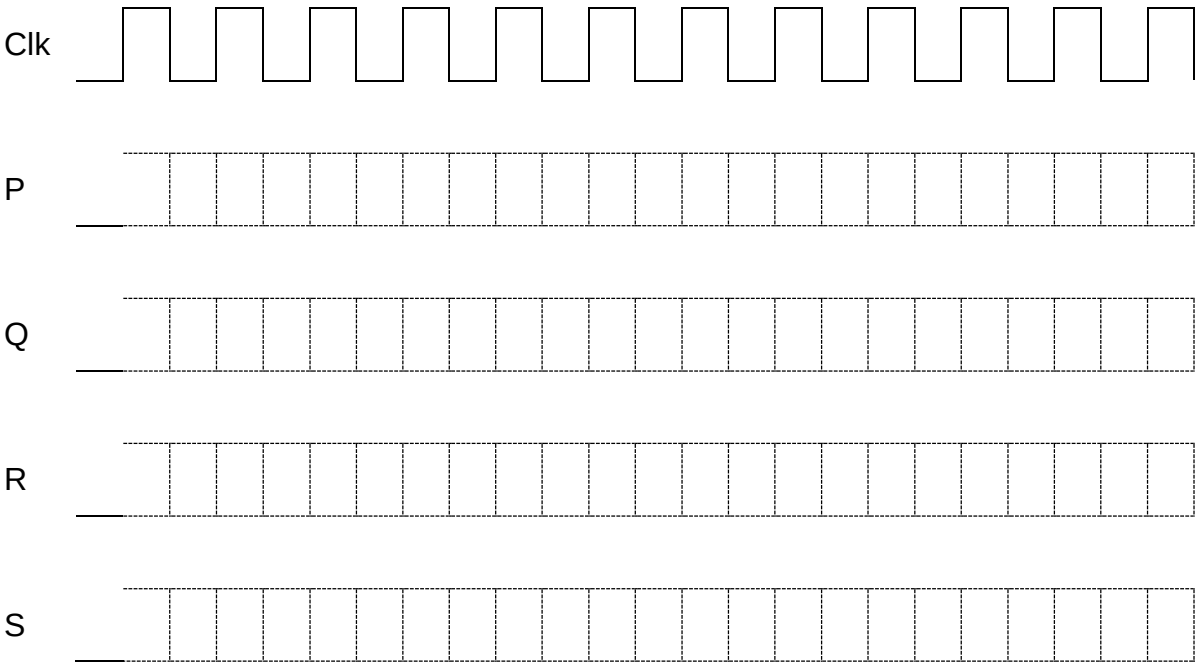
b) Explain why S and R are connected and wired as shown above.

..... /1

c) If the input is a square wave of frequency 512Hz, what is the frequency at S?

..... /1

d) Complete the timing diagram for the counter. /2



Spare diagram used (X) ☐

Question 21 continues

Marker use

e) Is the counter synchronous or asynchronous?

..... /1

Total Q21 /6

Question 22

Marker use

/3

Describe an advantage and a disadvantage of using the analogue to digital conversion method described by the Block Diagram shown in Figure 19, as opposed to other methods of analogue to digital conversion. In your answer, state the common name given to this method of conversion.

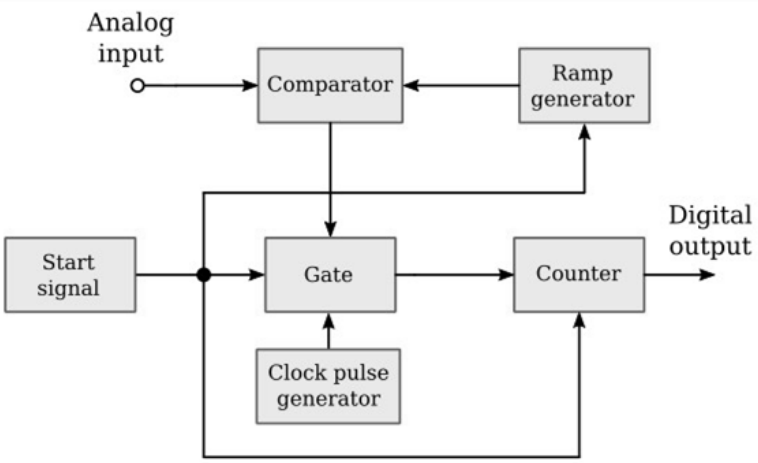


Figure 19: Block Diagram of an analogue to digital conversion circuit.

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.....

.....

Total Q22

/3

Spare Diagrams

Marker use

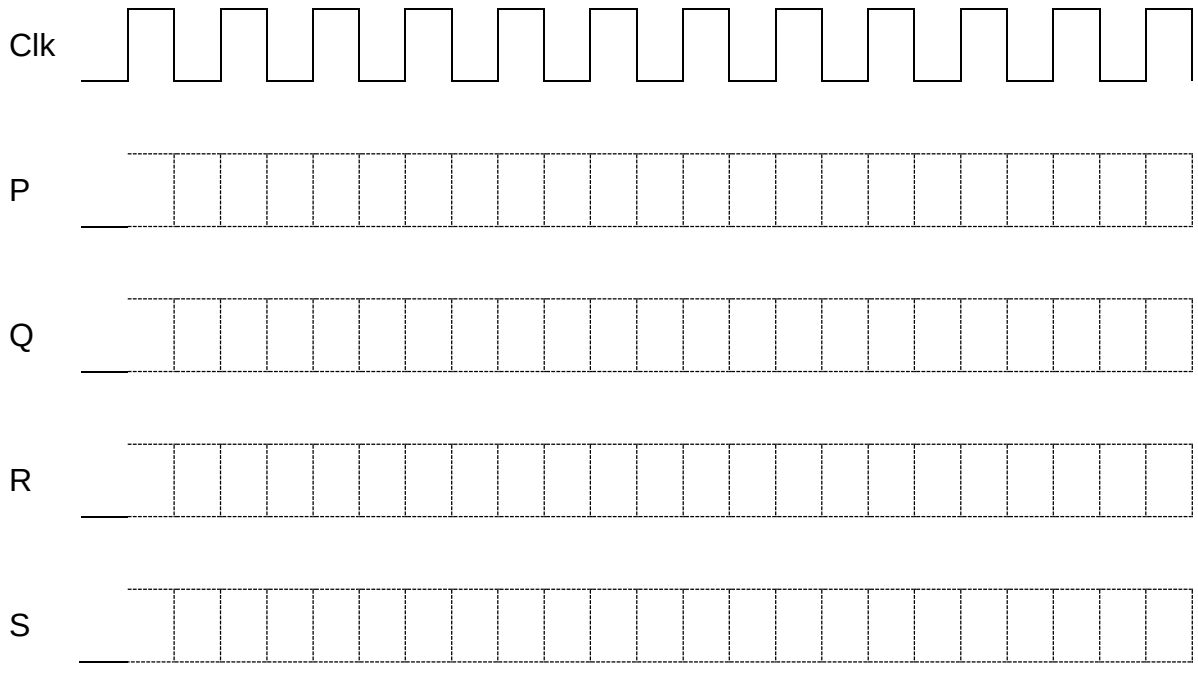
Question 19 e)

C	B	A	EN
0	0	0	
0	0	1	
1	1	1	

Question 20 b)

Darkness (Dark = 1)	Keys (In Ignition = 1)	Switch (On = 1)	Headlights (On = 1)	Alarm (On = 1)
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Question 21 d)



End of Section D

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ELECTRONICS AND ADVANCED TECHNOLOGIES

EAT315124

Section E

Pages: 12
Questions: 5
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C8	/ 36

Guide to Exam Structure

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Section E	5	5	36 minutes	36 marks
Totals	**27**	**27**	**180 minutes (3 hours)**	**180 marks**

Criterion

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

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

Question 23

Marker use

Circle the correct response for each of these questions.

a) Where is the program stored on a microcontroller?

/1

i. Input device.

ii. Memory.

iii. Power supply module.

iv. Processing core.

b) Which of the following is an output device?

/1

i. Fan.

ii. Thermistor.

iii. Light detector.

iv. Sensor.

c) Which of the following is a digital control?

/1

i. Adjusting the volume of music.

ii. Controlling the rotational speed of a motor.

iii. Varying the brightness of a light.

iv. Turning a heater on or off.

Total Q23

/3

Question 24

Marker use

UART (Universal Asynchronous Receiver-Transmitter) and SPI (Serial Peripheral Interface) are two different serial communication methods.

a) Describe the difference between 8-bit serial and 8-bit parallel communication.

.....

.....

.....

/2

b) Describe the differences between UART and SPI methods.

.....

.....

.....

/2

c) UART communication can be used to control a lamp and an air conditioner from a central device with only one signal wire going from the central device to the lamp and on to the air conditioner. Explain how this works.

.....

.....

.....

/2

d) Give an example of a device that would use SPI, and state why.

.....

.....

.....

/2

Total Q24

/8

Question 25

Marker use

a) Give **two (2)** reasons why microcontrollers have become more widespread.

/2

.....

.....

.....

.....

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.....

b) Give an example of a use for a microcontroller in two different industries.

/4

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Total Q25

/6

Question 26

Marker use

Yoshi has designed the circuit in Figure 20 which uses a microcontroller and a joystick to control which direction a DC motor spins. Figure 21 shows the microcontroller coding.

a) Outline **two (2)** advantages of using a microcontroller in a context such as this.

/4

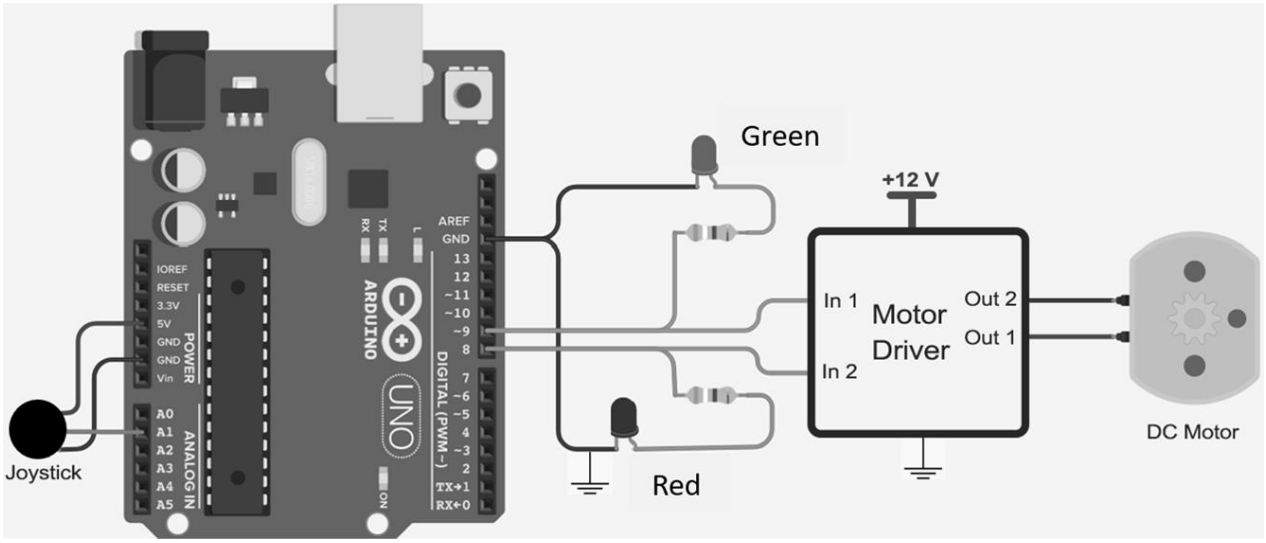

Figure 20: Block diagram showing analogue to digital conversion method.

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Question 26 continues

Marker use

```
int joyVal;
const int motorF = 9;
const int motorR = 8;
const int joystick = A1;

void setup()
{
  pinMode(motorF, OUTPUT); //motor pin
  pinMode(motorR, OUTPUT); //motor pin
  pinMode(joystick, INPUT); //joystick pin
}

void loop(){
  joyVal = analogRead(joystick);
  runMotor(joyVal);
  delay(1000);
}

void runMotor(int joyVal) {
  if (joyVal > 560) {
    digitalWrite(motorR, LOW);
    digitalWrite(motorF, HIGH);
  } else if (joyVal < 460){
    digitalWrite(motorF, LOW);
    digitalWrite(motorR, HIGH);
  } else {
    digitalWrite(motorF, LOW);
    digitalWrite(motorR, LOW);
  }
}
```

Figure 21: Picture of microcontroller coding.

b) Is the joystick connected as an analog or digital input?

.....

/1

c) Which coloured LED lights up with a joystick input value of 320?

.....

/1

d) For what range of joystick input values will the motor not run?

.....

/1

During testing, Yoshi discovers that the motor runs in reverse when it should be going forward, and that it responds very slowly to changes in the joystick's position.

e) What modifications could Yoshi make to address these concerns?

.....

/3

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.....

.....

Total Q26

/10

Question 27

Marker use

Michelle intends to use a microcontroller to control the temperature of a science experiment she is undertaking by using a heating element, temperature sensor and display. The microcontroller turns the element on when the temperature of the science experiment is lower than 60 °C, and off when it is more than 63 °C. The display shows the current temperature.

a) What output would you expect when the display gives the data shown in Figure 22?

/2

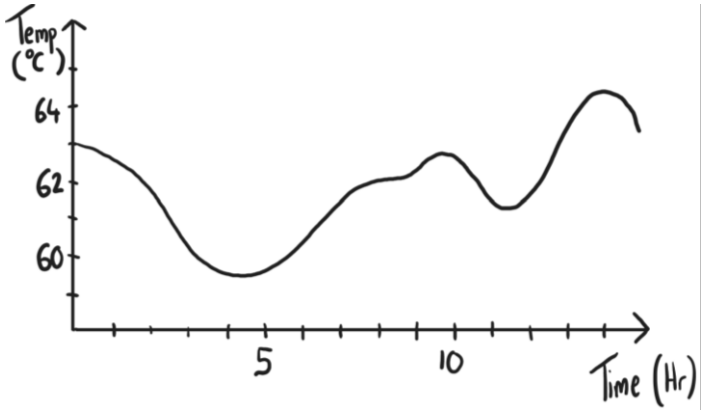

Figure 22: Graph showing the current temperature of a science experiment.

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b) Use any common programming language/structure to write some code which shows how the sensor data will be acquired, processed, and displayed.

/5

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Question 27 continues

Marker use

c) If Michelle were to use the microcontroller shown in Figure 23, which pin is a good option to connect the following to:

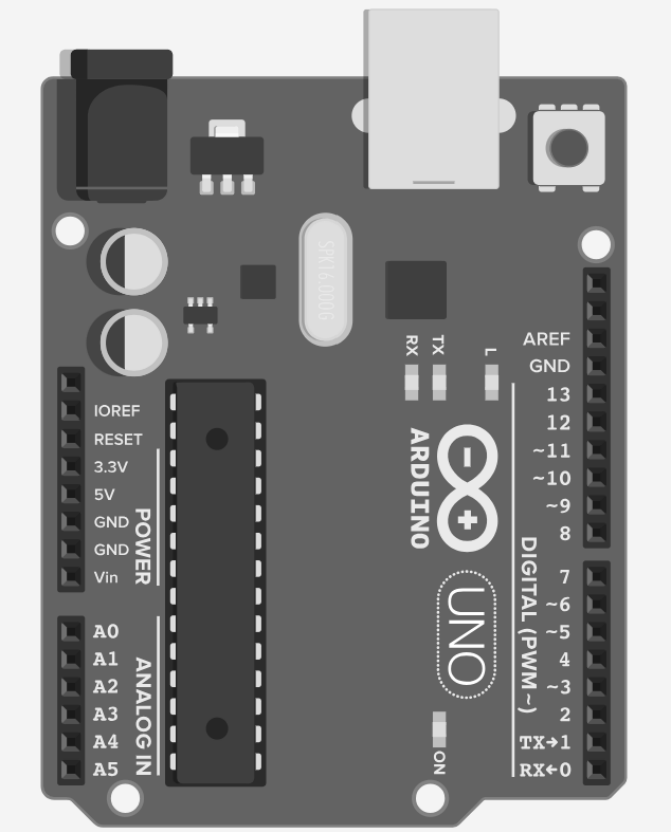

Figure 23: Microcontroller for connecting components.

i. Heating element.

..... /1

ii. Temperature sensor.

..... /1

.

Total Q27 /9

End of Section E

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