OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

Tasmanian Certificate of Education
External Assessment 2017

PLACE YOUR CANDIDATE LABEL HERE

ELECTRONICS

(ELT315114)

PART 1

Time: 90 minutes

Pages:	28
Questions:	15
Attachments:	Information Sheet

Candidate Instructions

1. You **MUST** make sure that your responses to the questions in this examination paper will show your achievement in the criteria being assessed.
2. Answer **ALL** questions. Answers must be written in the spaces provided on the examination paper.
3. You should make sure you answer all parts within each question so that the criterion can be assessed.
4. This examination is 3 hours in length. It is recommended that you spend approximately 90 minutes in total answering the questions in this booklet.
5. The 2017 External Examination Information Sheet for Electronics can be used throughout the examination.
6. No other written material is allowed into the examination.
7. All written responses must be in English.

On the basis of your performance in this examination, the examiners will provide results on each of the following criteria taken from the course statement:

Criterion 1 Apply knowledge and skills in designing, testing, building, and experimenting with circuits.

Criterion 4 Apply knowledge and understanding of digital and analogue circuits and their components.

Section Total	
C1	
C4	

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Additional Instructions for Candidates

When candidates are asked to ‘show that’:

- a candidate should calculate their own answer to three significant figures and use this subsequently.
- a candidate who is unable to determine the required value should use the value given by the examiner in subsequent questions.

For Marker Use Only

SECTION A

This section assesses **Criterion 1.**

Answer **ALL** questions in this section.

Question 1

Electrical connections are usually made on a printed circuit board (PCB) by soldering. When making a solder joint the conductors to be joined must first be heated and then the solder is melted to make the joint.

(a) Explain why melting solder onto the soldering iron tip and then applying it to the joint will result in an unsatisfactory joint. (1 mark)

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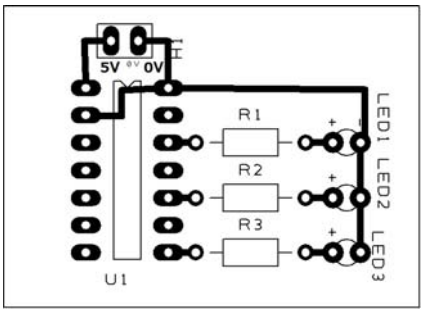
The microcontroller circuit on the PCB shown below failed to work when tested.



Testing with a digital multimeter showed approximately 5V on both the positive (pin 1) and the negative (pin 14) power supply pins of the IC.

It was later found that a solder joint was dry and not conducting. After repair the circuit worked as expected.

(b) In which conductor was the faulty joint? Explain your answer. (2 marks)

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Question 2

For Marker Use Only

An alarm system for a motorcycle is to be designed. The alarm circuit will detect when the motorcycle is lifted off the stand that it is parked on, triggering a position sensitive switch. An audible alarm will sound. The alarm's power is supplied through a key operated switch.

(a) Draw a function block diagram for the alarm as described above. Identify the inputs, processor(s) and outputs. (3 marks)

When constructed and tested on a breadboard it is found that simply returning the motorcycle to its resting position on its stand will stop the alarm from sounding.

(b) Redraw the block diagram to allow the alarm to continue sounding. (1 mark)

It is found that once triggered the alarm will sound until the motorcycle battery goes flat. This will breach noise regulations.

(c) Redraw the relevant part of the block diagram to include a solution to this problem. (1 mark)

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Question 3

For Marker Use Only

There are personal safety hazards apart from the high temperature of the soldering iron tip that must be considered when making soldered electrical connections.

(a) Describe one common soldering hazard and the steps that should be taken to minimise personal risk. (2 marks)

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(b) State a significant potential hazard and how personal injury or damage to the workplace can be avoided in each of the following stages of printed circuit board manufacturing. (4 marks)

(i) Removing unwanted copper from the board.

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(ii) Trimming the board to shape and smoothing the edges.

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(iii) Drilling the component holes.

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(iv) Drilling a large hole in the circuit board.

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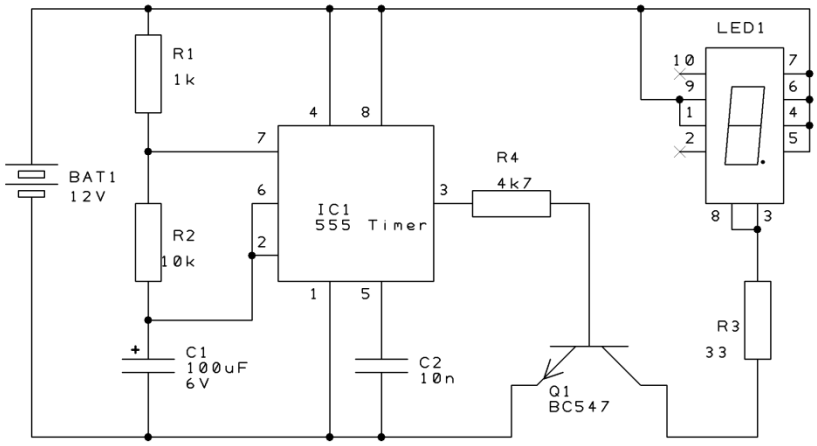
Question 4

For Marker Use Only

The circuit represented below is designed to have the LED display flash the letter 'A' repeatedly.



(a) What type of LED display is needed for LED1, Common Anode or Common Cathode? (1 mark)

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(b) When lit, each LED in the LED display passes 31mA. The BC547 transistor has a maximum collector current of 100mA. Explain the term 'collector current', and determine if the BC547 is suitable in this circuit. (2 marks)

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(c) Describe the changes that could be made to the circuit to increase its reliability. (3 marks)

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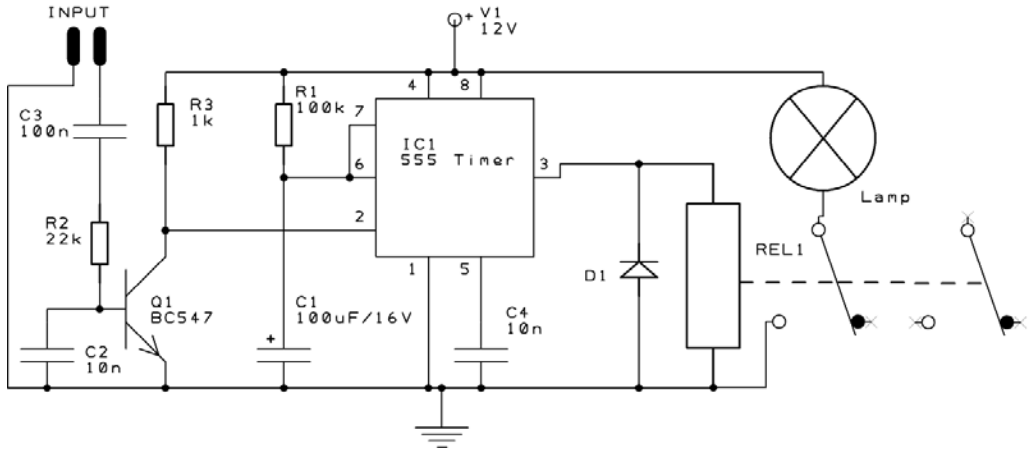
Question 5

For Marker Use Only

The circuit represented by the diagram below takes its input (a square wave) from the buzzer terminals of an electronic alarm clock. The alarm clock can be made to switch a light on for a period of time when the alarm sounds.



A student constructs the circuit on a breadboard but when the input (INPUT) is wired to a clock radio the relay (REL1) does not operate as expected.

(a) Describe how to test the transistor (Q1) without removing it from the circuit. (1 mark)

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(b) List the sequence of checks that should be made to troubleshoot the circuit on the breadboard. (3 marks)

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Question 5 continues.

Question 5 (continued)

For Marker Use Only

(c) Three test instruments are available for trouble shooting the circuit:

- an oscilloscope
- a logic probe
- a digital multimeter (DMM).

Explain how each might be used to check the circuit. (3 marks)

Oscilloscope: .....

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Logic probe: .....

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DMM: .....

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(d) Connecting the circuit to an alarm clock proves to be inconvenient for testing the circuit. Suggest a better way of providing an input for the circuit. (1 mark)

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Question 6

For Marker Use Only

Consider the two situations described below.

Situation 1:

Person 1 is changing a light bulb. To reach the light they stand on a plastic chair that is on a carpeted wooden floor. Accidentally the person touches the active 240VAC conductor.

Situation 2:

Person 2 is plugging in a vacuum cleaner to vacuum a freshly washed car and is standing with bare feet on the wet ground. The vacuum cleaner cable is faulty and the person comes into contact with the active 240VAC conductor.

(a) The 15A circuit breaker in the household wiring circuit offers them no protection from an electric shock. Explain why. (1 mark)

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Both of the situations are represented by the schematic circuit diagrams below. The resistors represent the resistances of the people and the items they are in contact with.

(b) Label the above diagrams to show what makes up each of the four resistances. (2 marks)

(c) What can be concluded about the value of resistance R2 compared to R4? (1 mark)

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Question 6 continues.

Question 6 (continued)

For Marker Use Only

(d) In which situation is the likelihood of a fatal shock greater? Explain why (with reference to the resistances in the circuits). (2 marks)

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(e) A residual current device (RCD) in the circuits involved would reduce the chance of serious electrical shock. Explain how RCDs work. (2 marks)

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Question 7

For Marker Use Only

Two commonly used types of capacitors are plastic film capacitors (polyester film is an example) and ceramic disc.

(a) What part of a capacitor is referred to by the names 'plastic film' and 'ceramic'? (1 mark)

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Plastic film capacitors usually have a rolled construction while ceramic discs are made from flat layers.

(b) Why are ceramic disc capacitors often a good choice for a circuit that is operating at higher signal frequencies? (1 mark)

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(c) For capacitance values over 1μF plastic film and ceramic disc capacitors are often not appropriate. Explain why and suggest a suitable alternative. (2 marks)

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(d) Capacitors have a voltage rating. Explain what this rating means. (1 mark)

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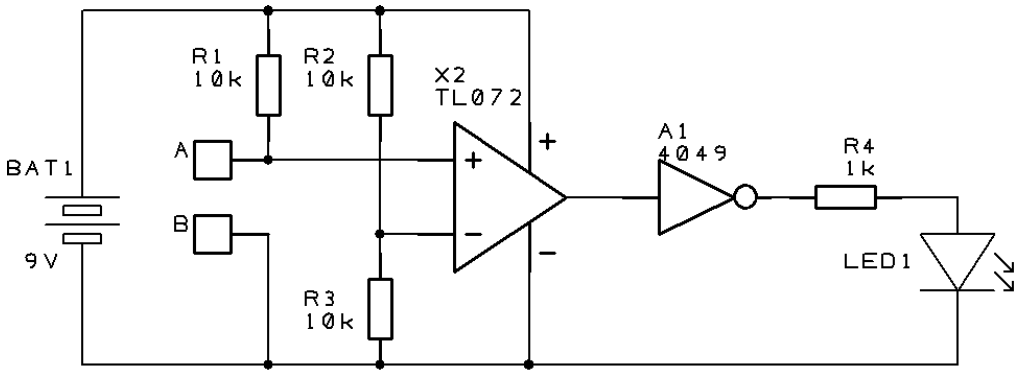
Question 8

For Marker Use Only

The circuit represented below is intended to light the LED when the resistance across input AB is less than 10 kilohms.



When built and tested the LED remains off regardless of the resistance across the input.

Examination of the relevant data sheets reveals:

- TL072 minimum output voltage is power supply minimum voltage plus 2V to 4V.
- 4049 maximum voltage of a logic low input is 2V.

(a) Explain why the circuit does not work. (2 marks)

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(b) Suggest a solution to the problem. (2 marks)

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SECTION B

For Marker Use Only

This section assesses **Criterion 4.**

Answer **ALL** questions in this section.

Question 9

Two resistors are connected together giving a total resistance of **less** than 1200 ohms. The resistors have these colour codes:

- Resistor 1 - green, blue, orange, brown
- Resistor 2 - brown, red, red, gold

(a) Give the resistance and tolerance of each resistor. (1 mark)

Resistor 1: .....

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Resistor 2: .....

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(b) Are the **resistors** connected in series or in parallel? Explain how you can determine this. (1 mark)

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(c) Calculate the total resistance of the two resistors. (1 mark)

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Question 9 continues.

Question 9 (continued)

For Marker Use Only

Two capacitors are connected together. The total capacitance of the connected capacitors is found to be **greater** than 100 nanofarads.

The capacitors have these codes printed on them:

Capacitor 1 104
Capacitor 2 332

(d) Give the capacitance value of each capacitor in both picofarads and nanofarads. (1 mark)

Capacitor 1: .....

Capacitor 2: .....

(e) Are the **capacitors** connected in series or in parallel? Explain how you can determine this. (1 mark)

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(f) Calculate the total capacitance of the two capacitors. (1 mark)

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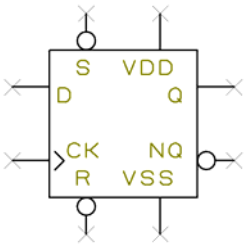
Question 10

For Marker Use Only

(a) On the diagram below show how to connect a D-type flip-flop to make a T-type flip-flop. (1 mark)



(b) Are the S and R inputs on the flip-flop represented above active high or active low? (1 mark)

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(c) If a square wave signal with a frequency of 6Hz is applied to the clock input of a T-type flip-flop, what will be the frequency of the output signal? (1 mark)

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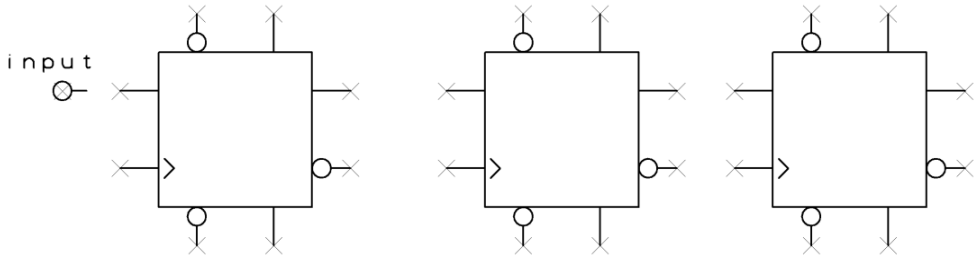
(d) Complete the diagram of a 3 bit ripple up counter connected to a 9V power supply. (3 marks)



Show all connection voltages:

Pin Name	Voltage
S	
R	
VDD	
VSS	

Question 10 continues.

Question 10 (continued)

For Marker Use Only

(e) Why is it essential that the S and R pins of each flip-flop are connected to the appropriate supply voltage? (1 mark)

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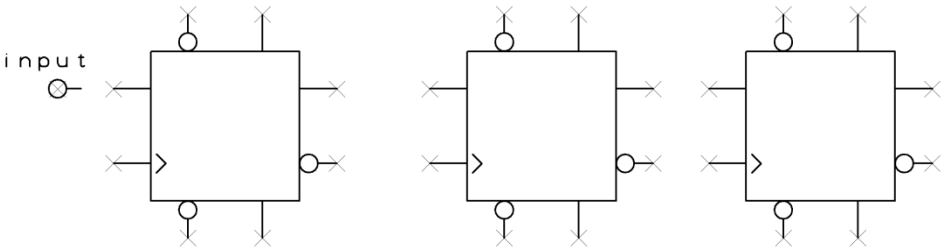
(f) On the diagram below show how the counter can be connected as a down counter. (2 marks)



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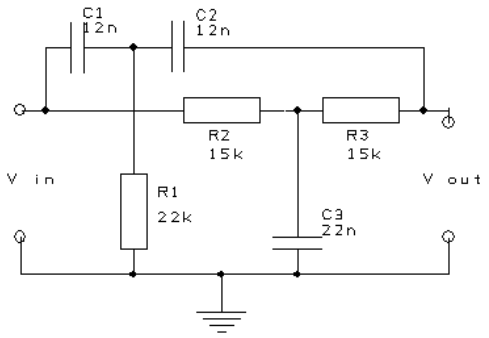
Question 11

For Marker Use Only

(a) Name the circuit represented by the diagram below. (1 mark)



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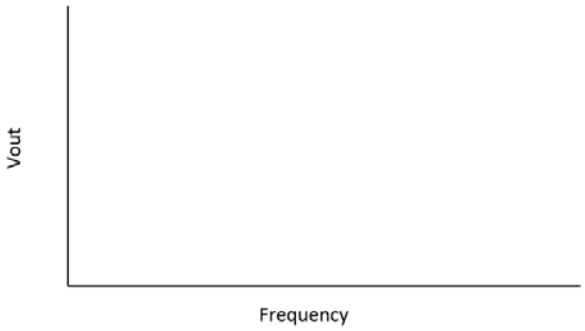
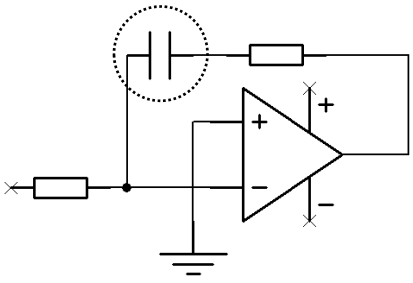
(b) Sketch a graph to show how the output voltage changes with frequency. No values of voltage or frequency are required. (1 mark)



(c) What is the effect of adding a capacitor (circled) to the inverting amplifier as shown below?

(1 mark)



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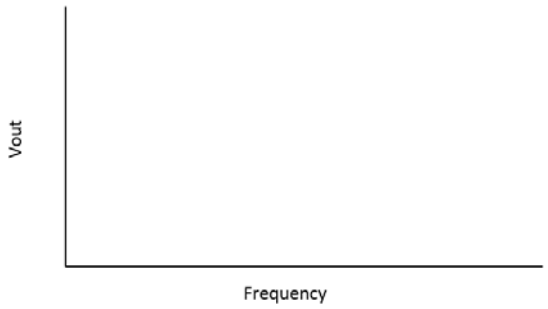
Question 11 continues.

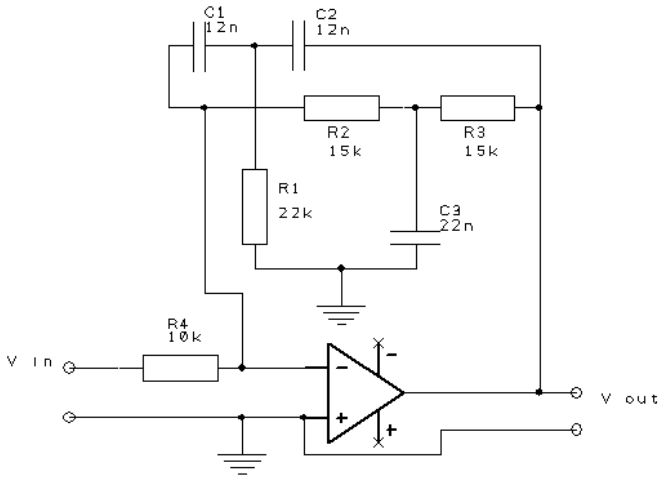
Question 11 (continued)

For Marker Use Only

(d) Sketch a graph to show how the output voltage changes using the frequency from part (c). No values of voltage or frequency are required. (1 mark)



(e) Describe the effect on the output of the circuit of adding the feedback components shown in the diagram below. (1 mark)



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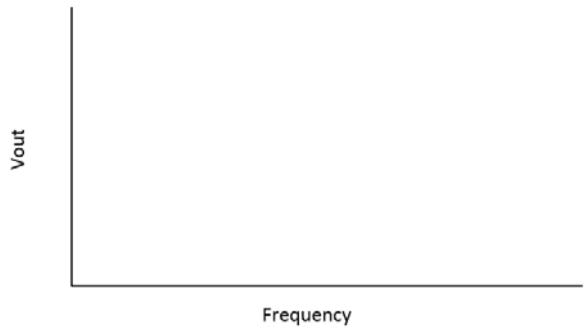
(f) Sketch a graph to show how the output voltage changes with frequency when the additional components are added. (1 mark)



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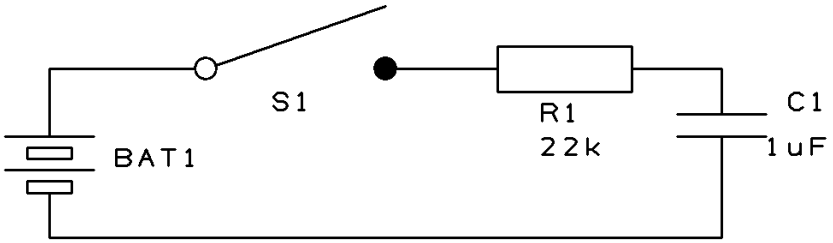
Question 12

For Marker Use Only

Consider the circuit represented below.



(a) Calculate the time constant of the RC pair, R1 and C1. (1 mark)

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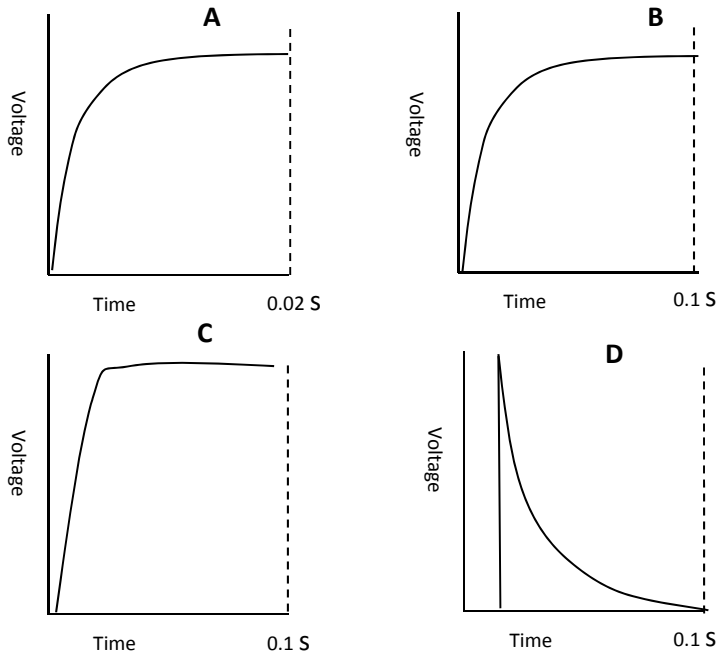
(b) The capacitor is fully discharged. Which of the following graphs best represents the voltage change across the capacitor when the switch is closed? (1 mark)



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The battery in the circuit above is replaced with a square wave source set to a frequency of 20Hz.

(c) Calculate the period of the 20Hz square wave. (1 mark)

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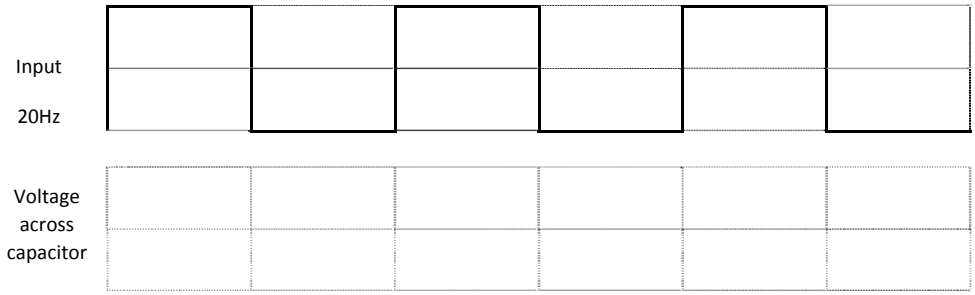
Question 12 continues.

Question 12 (continued)

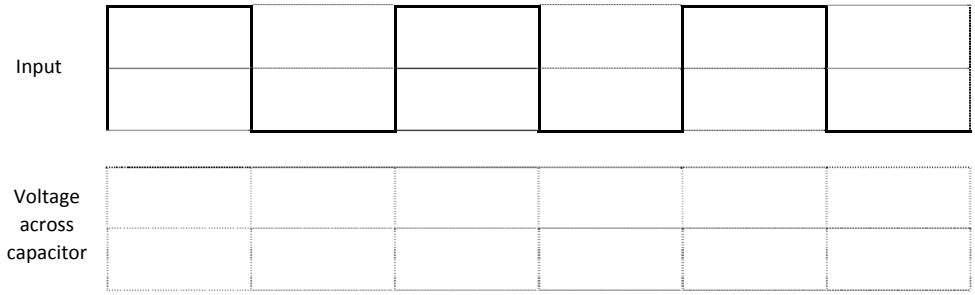
For Marker Use Only

(d) Complete the graph below to show the voltage change across the capacitor. (2 marks)



(e) The input signal frequency is increased to 20kHz.

Complete the graph below to show the voltage change across the capacitor. (2 marks)



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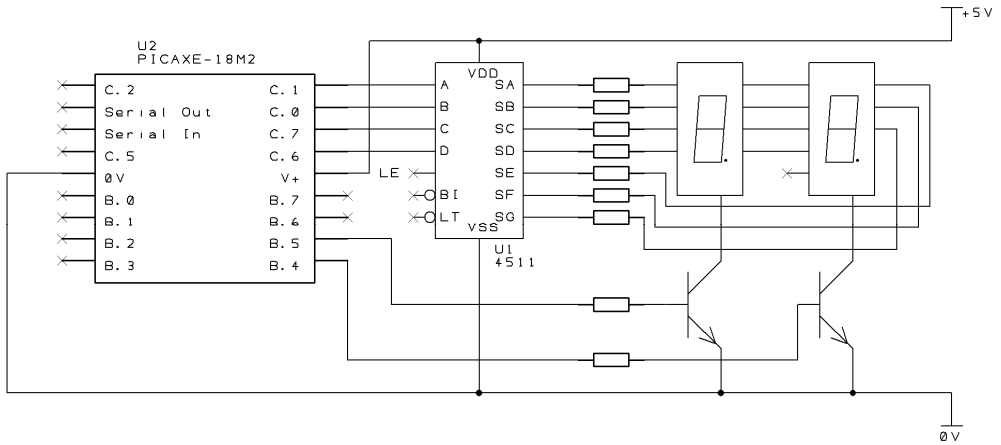
Question 13

For Marker Use Only

Refer to the circuit represented below.



(a) IC U1 is a decoder. Explain its role in this circuit. (1 mark)

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(b) There are two LED displays that can display from 00 to 99. Explain how one decoder can be used with two displays. (2 marks)

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(c) The decoder pin labelled 'LE' is the latch enable input. What is this pin's function? (1 mark)

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Question 13 continues.

Question 13 (continued)

For Marker Use Only

(d) Complete the table below to show the output states of the microcontroller when the display is showing '4'. (1 mark)

	C.6	C.7	C.0	C.1
Output = 4				

(e) The outputs, C.0, C.1, C.6 and C.7 of the microcontroller form a BCD code. Explain. (1 mark)

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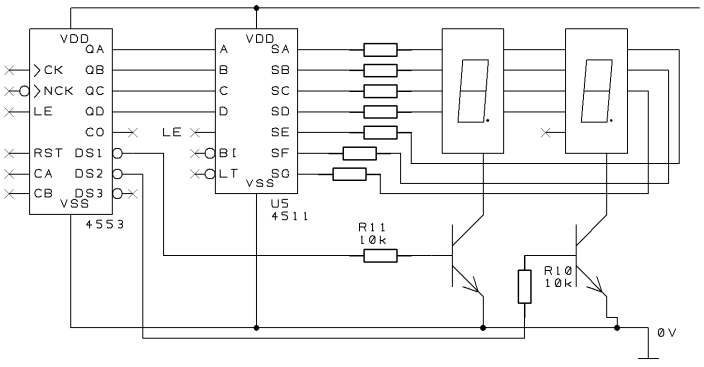
(f) Complete the table to show the states of the Picaxe outputs. The 0 in the number will be blanked (not lit) in each case. (1 mark)

	Output C.6	Output C.7	Output C.0	Output C.1	Output B.5	Output B.4
Display '05'						
Display '09'						

The incomplete circuit shown below uses a 4553 IC in place of the Picaxe used in the previous circuit.



(g) What are the advantages of microcontrollers over standard counter/encoder integrated circuits (for example, the 4553 BCD counter/encoder in the circuit above)? (1 mark)

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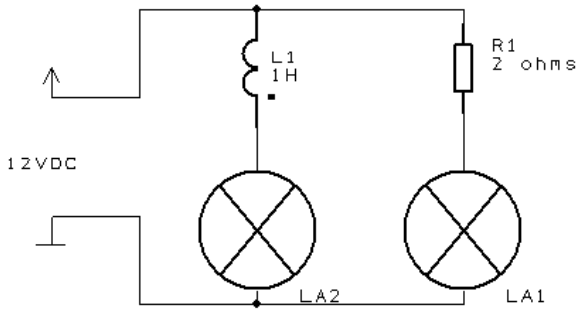
Question 14

For Marker Use Only

Consider the circuit represented below.



When tested it is found that both lamps, LA1 and LA2, glow with equal brightness.

(a) What would happen if the power supply is changed to 12VRMS AC, 50Hz? Explain your answer. (2 marks)

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(b) Sketch a circuit diagram for a passive high pass RL filter. (1 mark)

(c) RL filters are not as widely used as RC filters. Give a reason for this. (1 mark)

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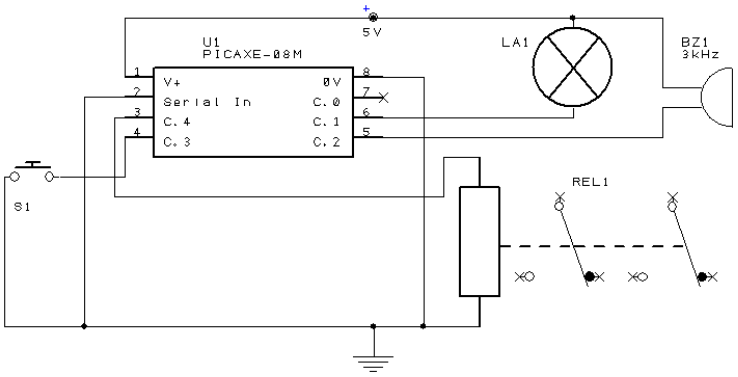
Question 15

For Marker Use Only

The diagram below represents a proposed circuit that is intended to activate a lamp, relay and high power 3kHz buzzer for 3 seconds when the push button switch is pressed.



The circuit has several faults including some that will result in damage to the Picaxe.

(a) There is a problem with the input at port C.3. Describe the problem and suggest a solution. (2 marks)

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(b) Explain how the outputs as they are shown (connected) will cause damage to the Picaxe. (2 marks)

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(c) Why is the serial in pin connected to 0V? (1 mark)

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OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

Tasmanian Certificate of Education
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PLACE YOUR CANDIDATE LABEL HERE

ELECTRONICS

(ELT315114)

PART 2

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Criterion 5 Apply knowledge of digital and analogue systems in describing the function and operation of components and circuits.

Criterion 7 Apply knowledge and understanding of mathematical concepts in electronics.

Section Total	
C5	
C7	

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For Marker Use Only

SECTION A

This section assesses **Criterion 5.**

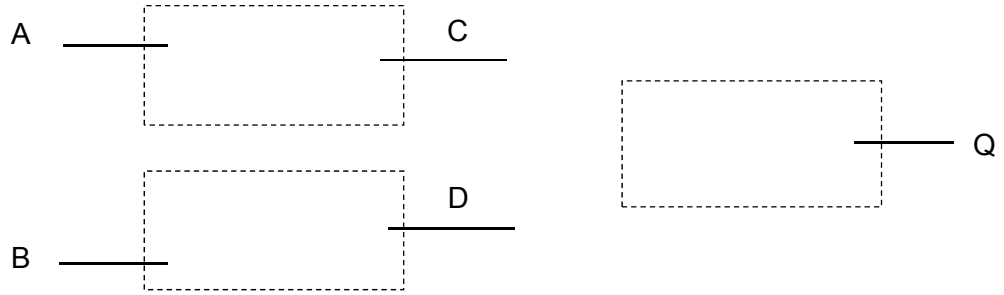
Answer **ALL** questions in this section.

Question 16

(a) Draw the appropriate logic gates in the boxes below and then complete the schematic diagram of a circuit that will perform this function: $Q = (A + B) \bullet \overline{(A \bullet B)}$ (2 marks)

Use only:

- One, 2-input AND gate
- One, 2-input OR gate
- One, 2-input NAND gate



(b) Complete this truth table for the circuit. (2 marks)

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

(c) Using only A, B and Q from the truth table write a Boolean expression for the logic gate produced by the circuit. (1 mark)

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(d) What type of logic gate is formed by the overall circuit? (1 mark)

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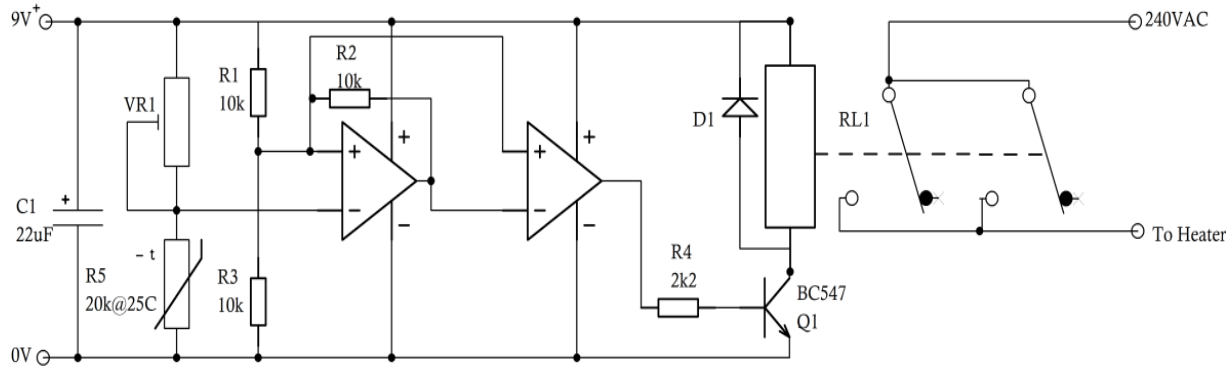
Question 17

For Marker Use Only

The circuit represented below is intended to operate the relay when the resistance of R5 is greater than 10 kilohms.



(a) Explain the role of the group of four components VR1, R5, R1 and R3. (2 marks)

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(b) How would the functioning of the circuit change if R2 is removed? (2 marks)

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(c) What is the role of diode D1? Explain what could happen if it is omitted. (2 marks)

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Question 17 continues.

Question 17 (continued)

For Marker Use Only

(d) As temperature decreases the resistance of R5 increases. Explain how the circuit switches on the heater as temperature falls. (3 marks)

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(e) How could the circuit be modified to control a refrigerator by making it switch on when the temperature rises? (1 mark)

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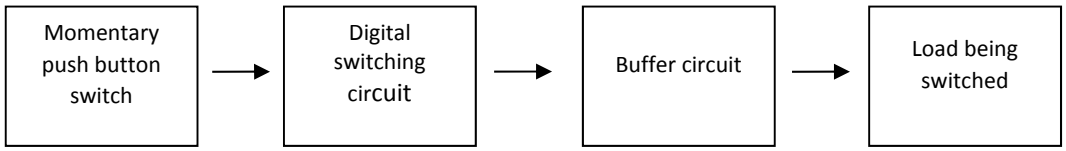
Question 18

For Marker Use Only

A student designs and builds a circuit that is to switch a load on and off using a momentary action push button switch. The block diagram for the circuit is below.



(a) The output of the switching circuit will need to toggle in response to the input. Explain what 'toggle' means. (1 mark)

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(b) Name an appropriate circuit for the digital switching circuit? (1 mark)

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It is found that when the push button switch is pressed the load seems to switch on or off at random. A press of the switch gives an unpredictable output.

(c) What is the most probable cause of the problem? (1 mark)

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(d) Describe a solution to the problem. (2 marks)

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Question 18 continues.

Question 18 (continued)

For Marker Use Only

(e) It is suggested that it would be useful if the output automatically switched off after being active for 10 seconds. Redraw the block diagram to include this function. (1 mark)

The buffer circuit is included to provide adequate current for the load.

(f) Draw a circuit diagram of a circuit using a transistor that could be used for the buffer. (1 mark)

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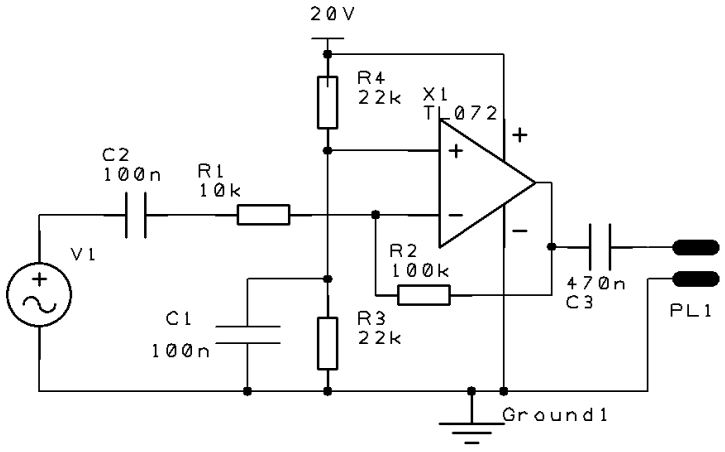
Question 19

For Marker Use Only

The schematic diagram of an AC amplifier is shown below.



(a) What is the role of R3 and R4? (1 mark)

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(b) What is the role of C2 and C3? (1 mark)

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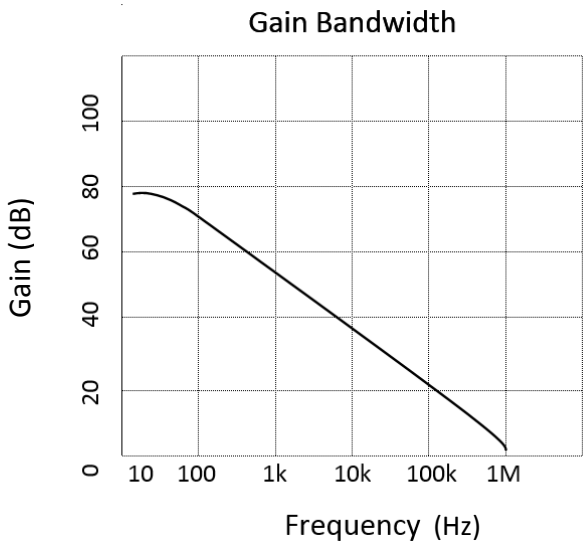
(c) The amplifier has a voltage gain of -10. Use the graph below to determine the highest frequency that can be amplified by -10 (20 dB). (1 mark)



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Question 19 continues.

Question 19 (continued)

For Marker Use Only

An amplifier is needed to amplify the output of an infra-red signal receiver. The signal frequency is 38 kHz and a gain of 40 dB is required.

(d) Will this circuit be suitable? If so, explain why it is suitable.

If it's not suitable, suggest changes to the amplifier circuit to allow it to work. (2 marks)

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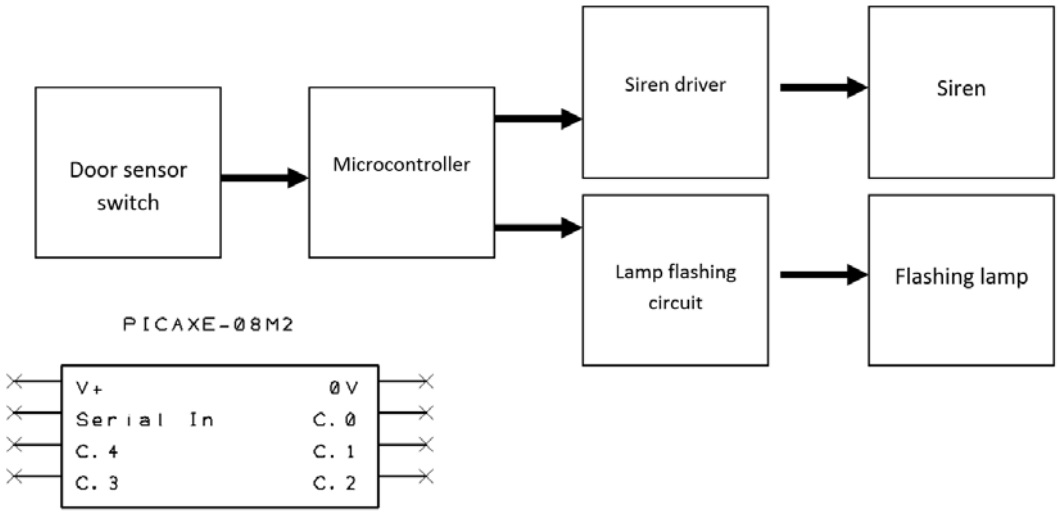
Question 20

For Marker Use Only

The block diagram below is for an intruder alarm system.



A Picaxe 08 microcontroller will be used in the circuit.

Complete the program for the microcontroller by adding lines of code as needed so that when the input sensor is activated there will be a 10 second delay before the outputs operate at a frequency of 1.0 Hz for 15 seconds. The alarm will then reset.

Outputs of the Picaxe 08 to be used are ports C.1 and C.2.
Input port C.3 is to be used.

Annotate the program: (5 marks)

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main:

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if pin c.3 = **1** then goto turn_on:

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goto main:

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Question 20 continues.

Question 20 (continued)

For Marker Use Only

turn_on:

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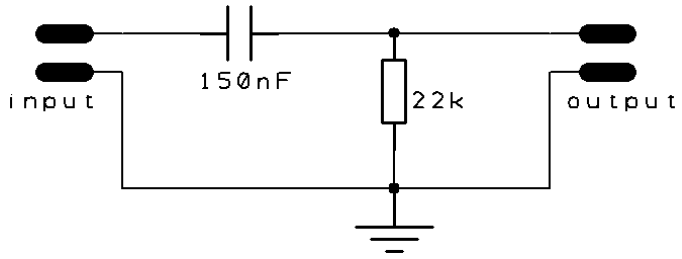
Question 21

For Marker Use Only

Consider the filter circuit represented below, with a cut-off frequency of about 48 Hz.



(a) Sketch a graph of this filter's response. Label the cut-off region, the pass band, the cut-off frequency and the axes of the graph. (3 marks)

(b) It is hoped that the circuit would have a higher cut-off frequency.

If the resistor can easily be changed should it be larger or smaller in value?

Explain your answer with reference to the cut-off frequency formula. (2 marks)

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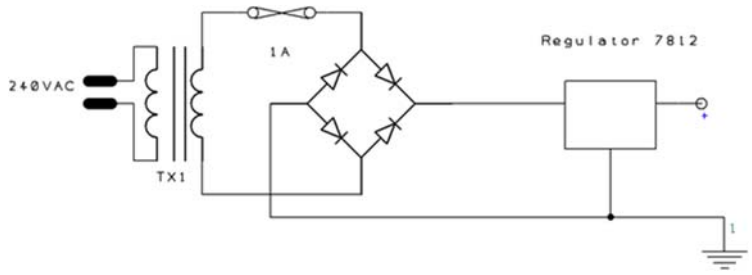
Question 22

For Marker Use Only

Consider the circuit represented below.



(a) If the turns ratio of the transformer (TX1) is 20:1 what is the voltage across its secondary winding? (1 mark)

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(b) Sketch the waveform that could be observed across the input of the regulator with an oscilloscope. (1 mark)

(c) (i) What is the maximum value of this voltage? (1 mark)

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(ii) Show this voltage and the RMS voltage on the graph above. (1 mark)

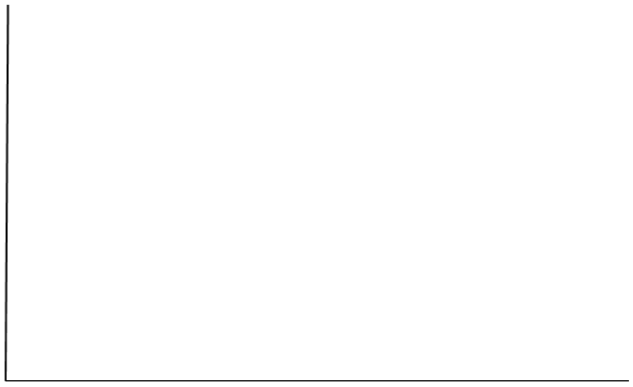
(d) Add a capacitor of appropriate type and value to the circuit to maintain a more steady input voltage for the regulator. (1 mark)

Question 22 continues.

Question 22 (continued)

For Marker Use Only

(e) Sketch the waveform at the input of the regulator after the capacitor has been added. (1 mark)



(f) Sketch the waveform across the regulator output. (1 mark)

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For Marker Use Only

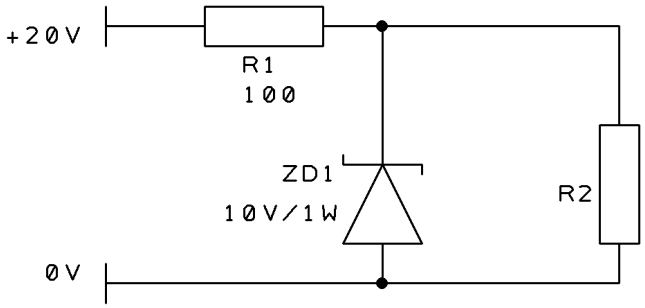
SECTION B

This section assesses **Criterion 7.**

Answer **ALL** questions in this section.

Question 23

The diagram below represents a simple power supply regulator. Zener diode (ZD1) is rated at 10 V/1 W. The input voltage (Vin) is 20V. The load (R2) is permanently connected.



(a) What voltage is across R1? (1 mark)

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(b) A current of 50 mA must pass through the load resistor. Calculate the maximum allowable value of R1. (1 mark)

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(c) Calculate the maximum permissible current through ZD1. (1 mark)

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(d) Calculate the lowest value of R1 that will prevent damage to ZD1. (1 mark)

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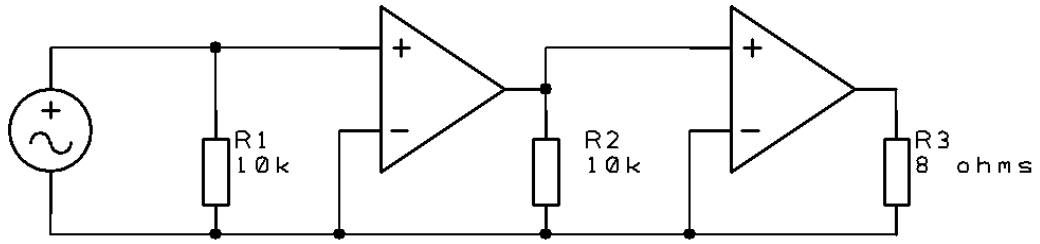
Question 24

For Marker Use Only

Refer to the two stage amplifier circuit below.



(a) Calculate the input power when the input voltage is 0.5 V AC RMS. (2 marks)

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(b) When the input voltage is 0.5 V AC RMS the voltage across R3 is 22 V AC RMS calculate the voltage gain of the two stage amplifier. (2 marks)

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(c) Calculate the output power through R3. (2 marks)

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(d) Why is it best to **not** express the voltage gain of this two stage amplifier in decibels? (1 mark)

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Question 24 continues.

Question 24 (continued)

For Marker Use Only

(e) Calculate the power gain of the two stage amplifier in decibels. (3 marks)

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(f) When the input voltage is 0.5 V the voltage across R2 is 5 V calculate the power gain of the first amplifier stage in decibels. (3 marks)

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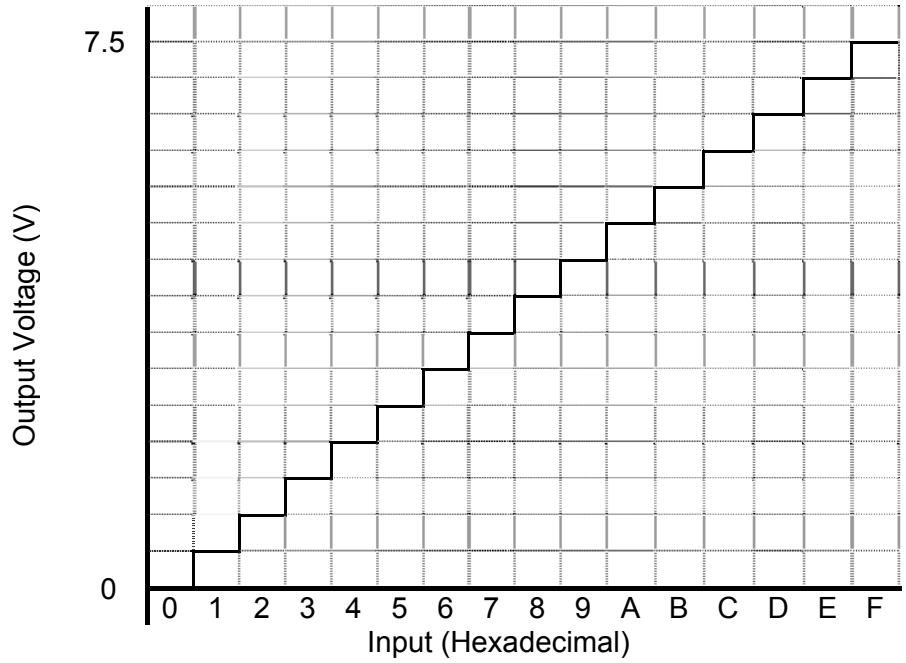
Question 25

For Marker Use Only

The graph below represents the output of a four bit Digital to Analogue Converter (DAC). The output voltage corresponds to the hexadecimal input value.



(a) What is the output voltage when the input is $1_{(16)}$? (1 mark)

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(b) What is the output voltage when the input is $8_{(16)}$? (1 mark)

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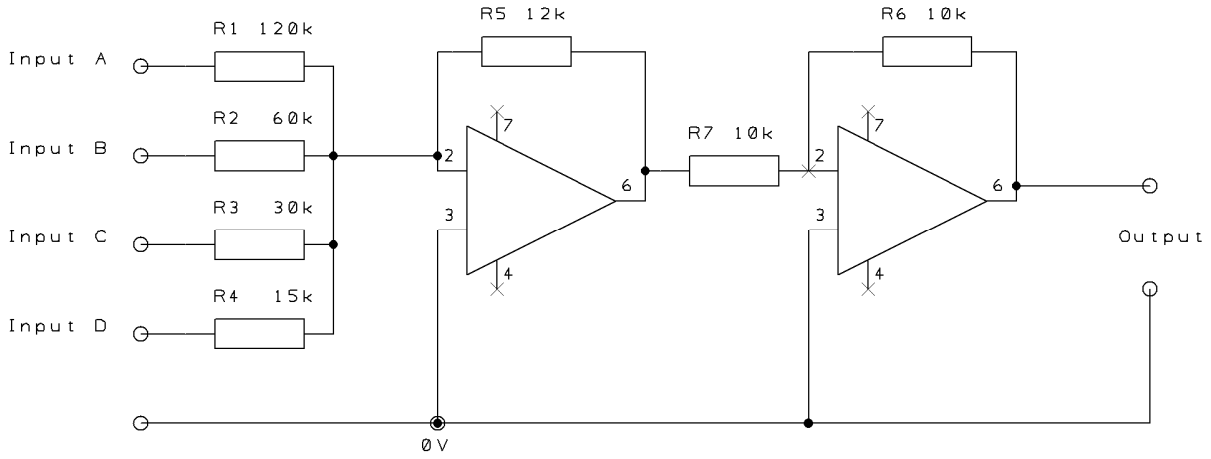
Question 25 continues.

Question 25 (continued)

For Marker Use Only

The diagram below represents the DAC circuit used.



(c) When the input is A_{16}, what is the binary value of the input? Show your working. (1 mark)

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(d) What is the logic high voltage at Input A? Show how this is determined. (2 marks)

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All inputs have the same logic high voltage.

(e) Calculate the output voltage when the input is A_{16}. Show your working. (2 marks)

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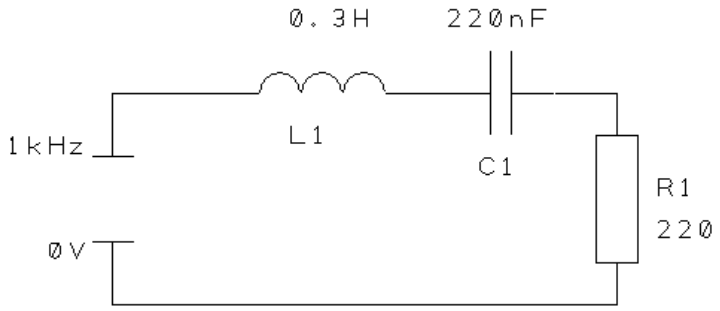
Question 26

For Marker Use Only

Refer to the circuit below.



(a) The input voltage is adjusted so that the voltage across R1 is 22 V. Calculate the current through the circuit. (1 mark)

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(b) Calculate the impedance of the circuit at 1 kHz. (3 marks)

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(c) Calculate the resonant frequency of the circuit. (3 marks)

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(d) What is the impedance of the circuit at its resonant frequency? (1 mark)

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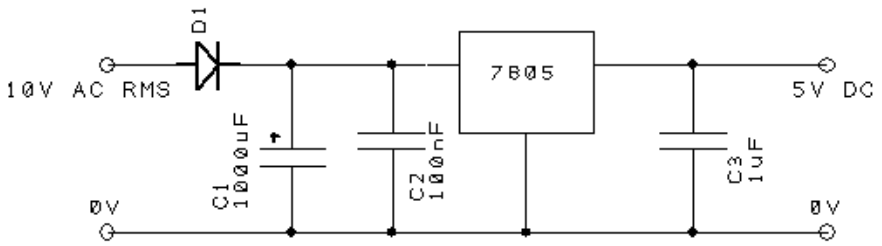
Question 27

For Marker Use Only

The diagram below represents a regulated power supply.



(a) Calculate the peak voltage of the input voltage. (2 marks)

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(b) Calculate the voltage drop across the 7805. (1 mark)

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(c) When 500 mA is passing through a load connected to the output, how much power is being dissipated as heat by the 7805? (2 marks)

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Question 28

For Marker Use Only

You **must** show your workings.

(a) Convert $3E7_{16}$ to decimal. (1 mark)

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(b) Convert 652_{10} to hexadecimal. (1 mark)

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(c) Convert 350_{10} and 55_{10} to binary and then binary add them. (2 marks)

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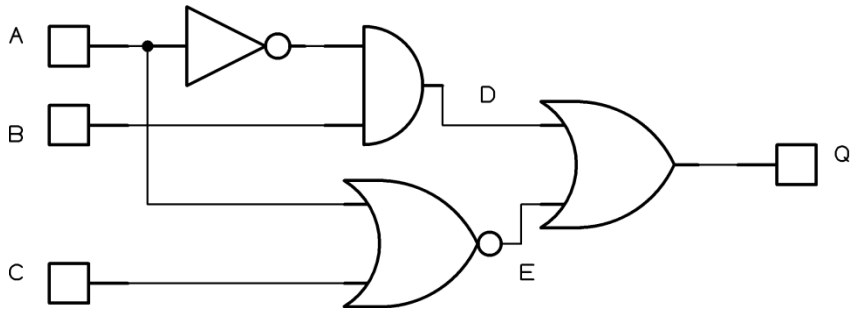
Question 29

For Marker Use Only

Consider the logic circuit represented below.



(a) Write a Boolean statement to express the function of the circuit. (1 mark)

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(b) Complete the below truth table. (2 marks)

A	B	C	D	E	Q

(c) Which input, A, B or C could be considered as an active low enable input? (1 mark)

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