BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

PHYSICS AND MATHEMATICS DEPARTMENT

-- DEC 2019

PH005: BASIC ELECTRONICS

TIME: 3 HOURS

INSTRUCTIONS

Answer **ALL of question one** in Section A and **any three** questions from Section B. Section A carries 40 Marks and each question in Section B caries 20 marks.

Note: Where no units are specified, assume they are S.I.

SECTION A

1. (a) What is a transducer? [2]

(b) List any two input and two output transducers. [4]

(c) List any three major properties of an ideal op-amp. [6]

(d) State three disadvantages of increased gain in an op-amp. [6]

(e) Draw the circuit symbol of an OR gate and construct its truth table. [6]

(f) Using NAND gates only, show how you can implement the following logic gates:

(i) NOT gate.

(ii) AND gate. [3, 3]

(g) List any two advantages and any two disadvantages of advances in electronics. [4]

(h) A student designs a flood warning system. When the humidity goes above a set level, a signal that operates a siren is produced. Draw a system diagram by choosing appropriate input, process, and output subsystems from the list below.

Alarm (audible warning device); comparator; humidity sensor [6]

SECTION B

2. (a) The sensing device in figure 1 below is a negative temperature coefficient thermistor.

(i) What happens to the thermistor's resistance and eventually, the output voltage V_0 as:

a. the thermistor cools? and [4]

b. the thermistor becomes hot? [4]

(ii) Give any real life application of the circuit shown in Figure 1. [2]

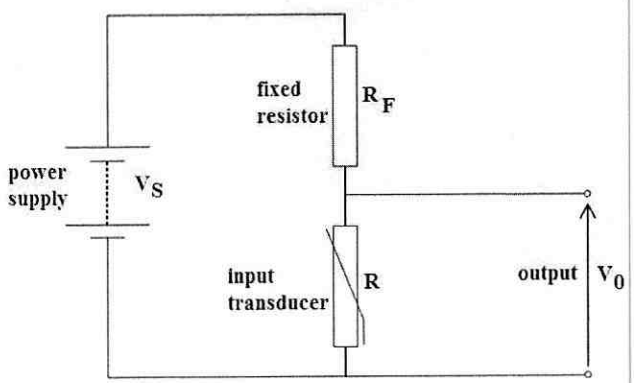

Figure 1: Potential divider circuit

(b) The LED in Figure 2 needs a current of 5mA and a forward voltage drop of 1V across it to make it light correctly.

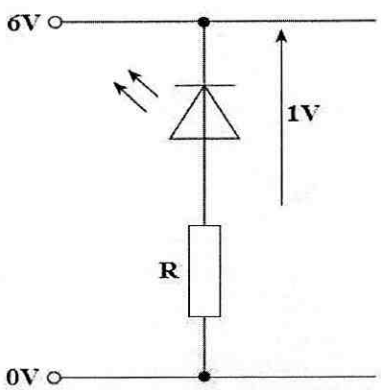

Figure 2: LED in series with a resistor R.

(i) Calculate the amount of power used by the LED. [3]

(ii) Given that the LED is on:

1. what is the current through resistor R? [3]
2. calculate the voltage across resistor R. [4]

3. Figure 3 shows an amplifier circuit incorporating an ideal op amp.

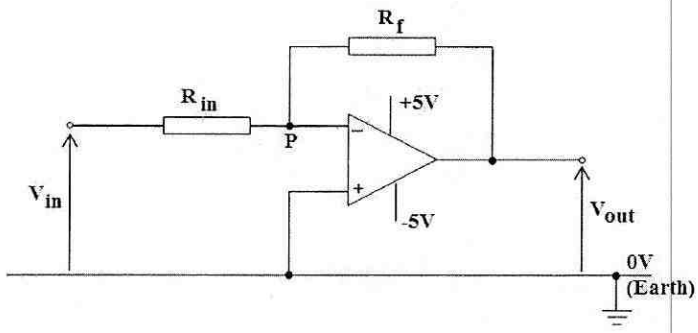

Figure 3: Op-amp circuit.

(a) What type of op-amp is shown in Figure 3? [2]

(b) The op-amp in Figure 3 uses negative feedback. Explain what is meant by negative feedback. [3]

(c) With reference to Figure 3, explain why the potential at point P is approximately 0V unless the op-amp is saturated. [5]

(d) Derive an expression for the gain of the amplifier circuit in terms of the input resistance Rin and the feedback resistance Rf. [6]

(e) In one particular application of the circuit, the gain of the amplifier is -10. State the value of the output voltage V_{out} when the input voltage Vin is:

(i) +0.1V.

(ii) -1.0 V. [2, 2]

4.(a) Table 1 shows how the input sensors A and B of an electronic system control the outputs P, Q and R.

Table 1: The truth table showing how the input sensors control the output.

A	B	P	Q	R
0	0	1	1	1
1	0	0	1	0
0	1	0	1	1
1	1	0	0	0

(i) Which type of logic gate will produce the P output? [3]

(ii) Which type of logic gate will produce the Q output? [3]

(iii) Write down an expression which describes the R output. [4]

(b) A circuit with an on/off switch is shown in Figure 4.

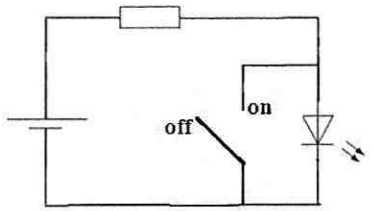

Figure 4: A circuit with an on/off switch.

(i) What is the state of the LED when the switch is:

a. on, and [3]

b. off [3]

(ii) Which logic gate behaves in the same way as Figure 4? Explain your answer. [4]

5. A logic circuit with two inputs X and Y and output Q has the following the Boolean equation:

$$Q = (\bar{X} + \bar{Y}).(X + Y)$$

(a) Copy and complete Table 2. [10]

Table 2: Truth table

X	Y	$\bar{X}$	$\bar{Y}$	$\bar{X}+\bar{Y}$	$\bar{X}$	Q
0	0					
1	0					
0	1					
1	1					

(b) Complete Figure 5 to show how a logic circuit can be constructed from two NOT gates, two OR gates and one AND gate to represent the Boolean equation above. [8]

Figure 5: Part of a logic circuit

(c) State which single logic gate has the same function as the complete circuit above. [2]

6. A student designs a noise warning system to alert the user to the presence of a noise level likely to damage hearing. An LED flashes on and off when the noise level exceeds a safe value.

(a) Label each subsystem in Figure 6 to show a possible design for the noise warning system using the following subsystems: comparator, LED and sound sensor. [6]

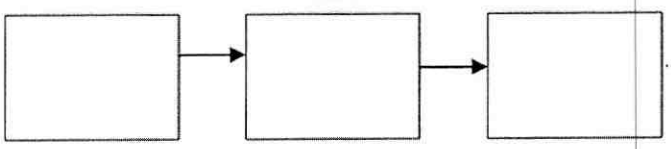

Figure 6: A possible design for a noise warning system.

(b) In which subsystem could an op-amp be used? [2]

(c) A comparator circuit diagram is shown in Figure 7. Calculate the voltage at point Y in this circuit. [4]

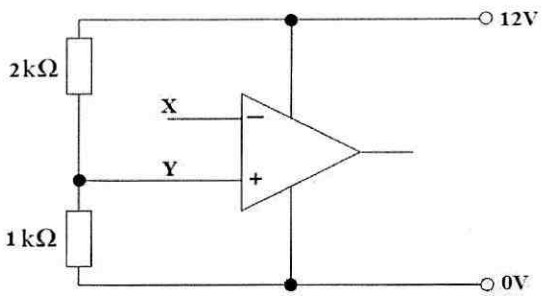

Figure 7: A comparator circuit.

(d) A signal from a sound sensor is connected to point X in the comparator circuit (Figure 7). What voltage would you expect from the output of this circuit when;

(i) the voltage at X is 2V? [4]

(ii) the voltage at X rises to 6V? [4]

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