

1 (a) Fig. 8.1 shows a circuit incorporating an ideal operational amplifier (op-amp).

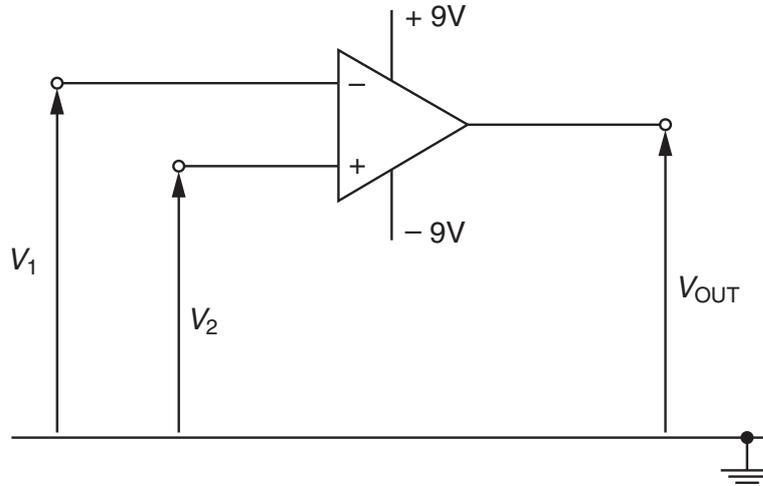


Fig. 8.1

The voltages applied to the inverting and the non-inverting inputs are V_1 and V_2 respectively.

State the value of the output voltage V_{OUT} when

(i) $V_1 > V_2$,

$$V_{OUT} = \dots\dots\dots V$$

(ii) $V_1 < V_2$.

$$V_{OUT} = \dots\dots\dots V$$

[1]

(b) The circuit of Fig. 8.2 is used to monitor the input voltage V_{IN} .

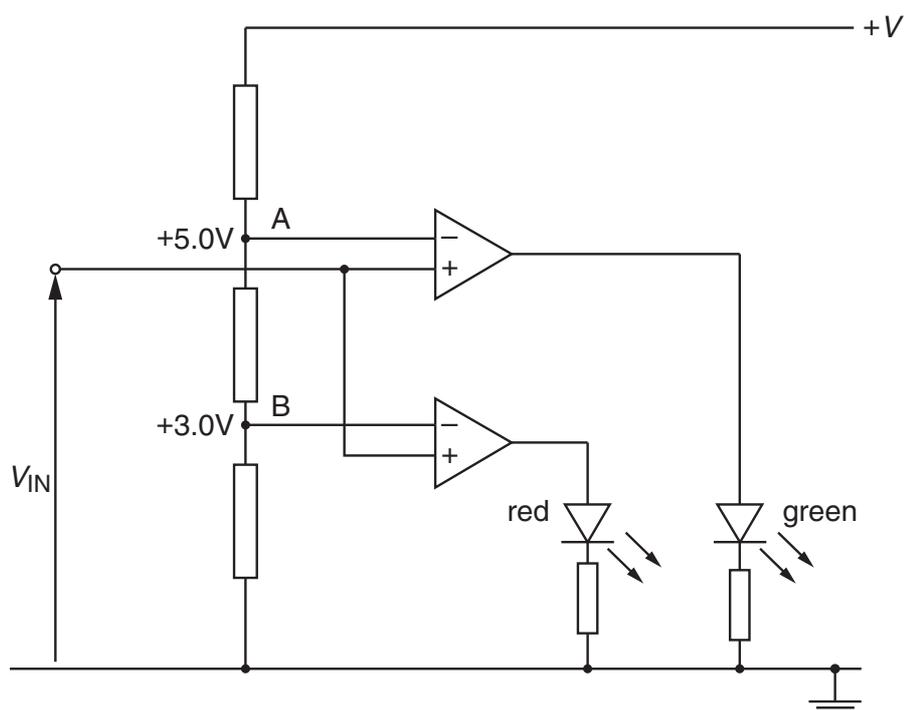


Fig. 8.2

At point A, a potential of 5.0V is maintained. At point B, a potential of 3.0V is maintained.

Complete Fig. 8.3 by indicating with a tick (✓) the light-emitting diodes (LEDs) that are conducting for the input voltages V_{IN} shown. Also, mark with a cross (✗) those LEDs that are not conducting.

V_{IN} / V	red LED	green LED
+2.0		
+4.0		
+6.0		

Fig. 8.3

- 2 (a) The circuit for an amplifier incorporating an ideal operational amplifier (op-amp) is shown in Fig. 10.1.

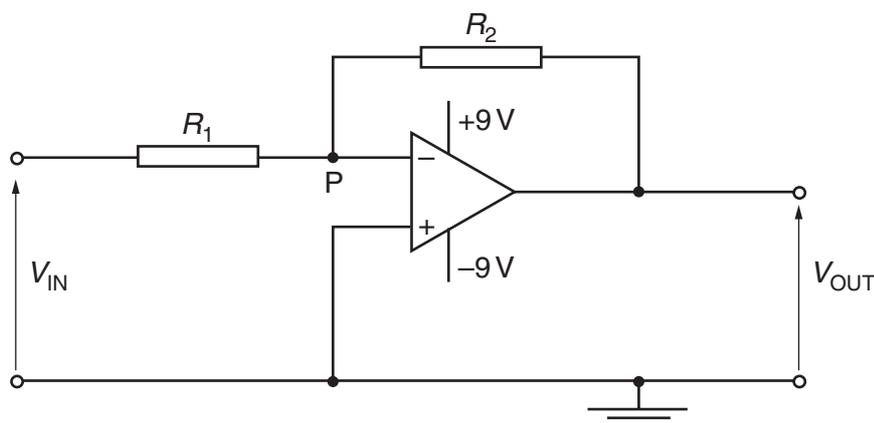


Fig. 10.1

- (i) State

1. the name of this type of amplifier circuit,

..... [1]

2. why the point P is referred to as a *virtual earth*.

.....

 [3]

- (ii) Show that the gain G of this amplifier circuit is given by the expression

$$G = -\frac{R_2}{R_1}.$$

Explain your working.

- (b) The circuit of Fig. 10.1 is modified by connecting a light-dependent resistor (LDR) as shown in Fig. 10.2.

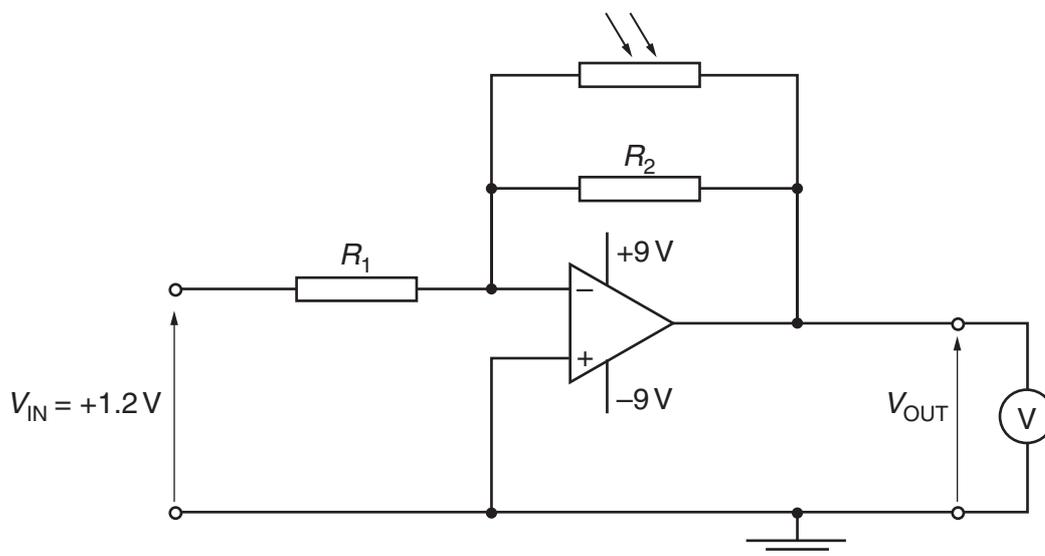


Fig. 10.2

The resistances R_1 and R_2 are $5.0\text{ k}\Omega$ and $50\text{ k}\Omega$ respectively.

The input voltage V_{IN} is $+1.2\text{ V}$. A high-resistance voltmeter measures the output V_{OUT} . The circuit is used to monitor low light intensities.

- (i) Determine the voltmeter reading for light intensities such that the LDR has a resistance of

1. $100\text{ k}\Omega$,

reading = V [3]

2. $10\text{ k}\Omega$.

reading = V [2]

(ii) The light incident on the LDR is provided by a single lamp. Use your answers in (i) to describe and explain qualitatively the variation of the voltmeter reading as the lamp is moved away from the LDR.

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.....

.....

..... [3]

3 (a) State three characteristics of an ideal operational amplifier (op-amp).

1.
2.
3. [3]

(b) An amplifier circuit for a microphone is shown in Fig. 8.1.

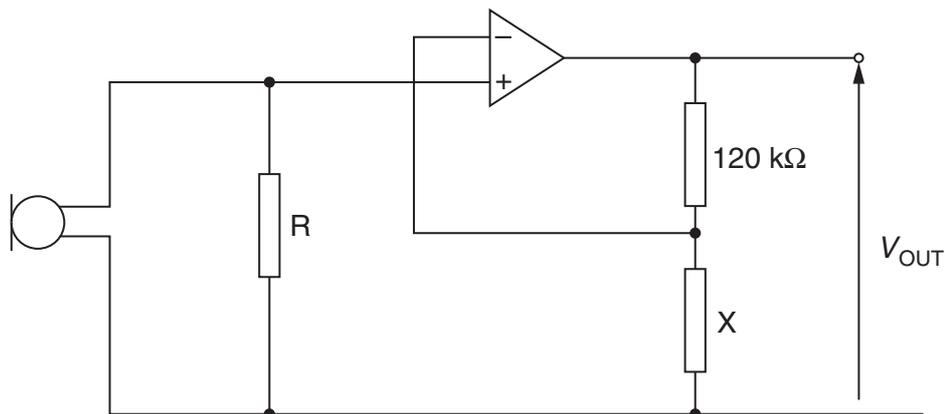


Fig. 8.1

(i) Name the type of feedback used with this op-amp.

..... [1]

(ii) The output potential difference V_{OUT} is 5.8V for a potential difference across the resistor R of 69mV. Calculate

1. the gain of the amplifier circuit,

gain = [1]

2. the resistance of resistor X.

resistance = Ω [2]

(iii) State one effect on the amplifier output of reducing the resistance of resistor X.

.....

..... [1]

- 4 A block diagram for an electronic sensor is shown in Fig. 9.1.



Fig. 9.1

- (a) Complete Fig. 9.1 by labelling the remaining boxes. [2]
- (b) A device is to be built that will emit a red light when its input is at +2 V. When the input is at -2V, the light emitted is to be green.
- (i) On Fig. 9.2, draw a circuit diagram of the device.

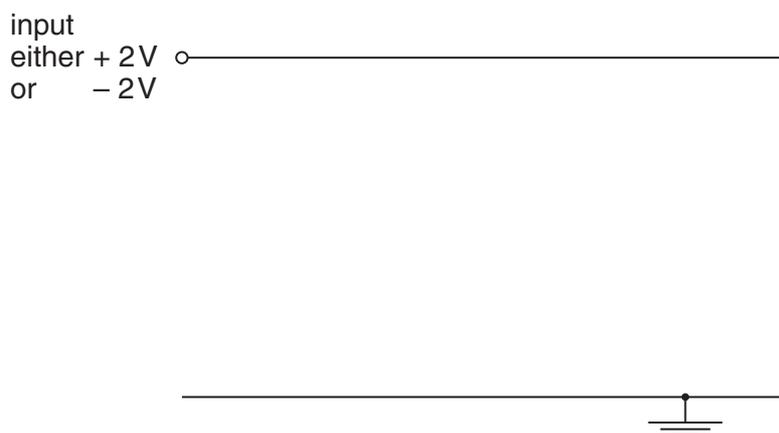


Fig. 9.2

[2]

- (ii) Explain briefly the action of this device.

.....

..... [1]

6 (a) Explain the principles behind the use of X-rays for imaging internal body structures.

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.....
.....
.....
.....
.....
..... [4]

(b) Describe how the image produced during CT scanning differs from that produced by X-ray imaging.

.....
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.....
..... [5]

7 (a) State what is meant by *acoustic impedance*.

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.....[1]

(b) Explain why acoustic impedance is important when considering reflection of ultrasound at the boundary between two media.

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.....[2]

(c) Explain the principles behind the use of ultrasound to obtain diagnostic information about structures within the body.

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.....[5]

8 (a) Distinguish between the images produced by CT scanning and X-ray imaging.

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.....[3]

(b) By reference to the principles of CT scanning, suggest why CT scanning could not be developed before powerful computers were available.

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.....[5]

- 9 An analogue signal is sampled at a frequency of 5.0kHz. Each sample is converted into a four-bit number and transmitted as a digital signal. Fig. 10.1 shows part of the digital signal.

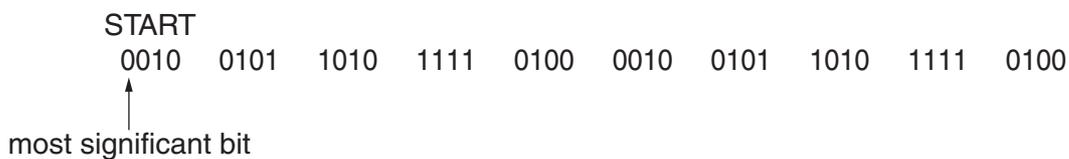
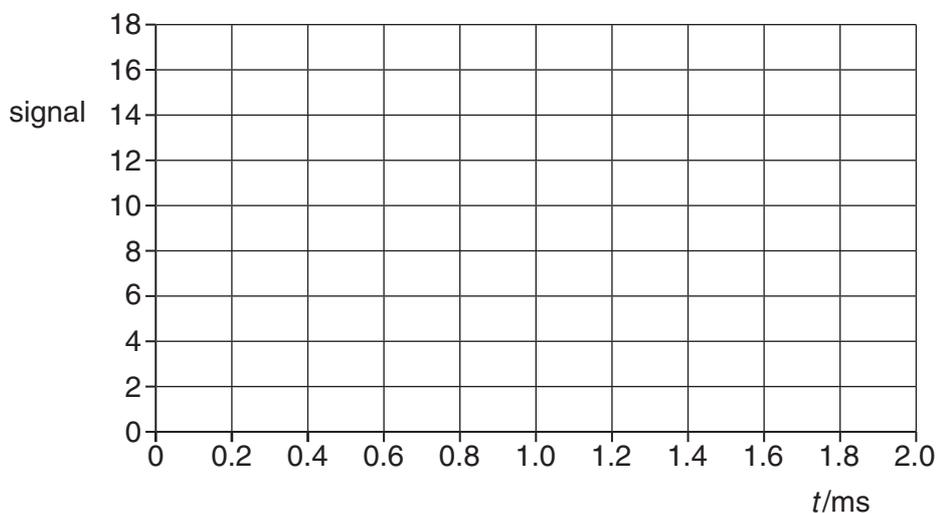


Fig. 10.1

The digital signal is transmitted and is finally converted into an analogue signal.

- (a) On the axes of Fig. 10.2, sketch a graph to show the variation with time t of this final analogue signal.



[4]

Fig. 10.2

- (b) Suggest two ways in which the reproduction of the original analogue signal could be improved.

1.
-
2.
-

[2]