Unit 8 INSTRUMENTATION

Warm-up

Complete the text with the words below

measurement variables record pressure solve flow

Instrumentation Engineering uses instruments to measure, _____ and control process _____ such as,_____ temperature, level and _____. It is known as the "art and science of _____ control". Instrument engineers use measuring techniques, controlling and automation equipment and they _____ problems related to measuring, monitoring and control instruments.

Task 1

Instrumentation is used to measure many parameters (physical values). Do you know the English equivalents of these?

Ciśnienie _ _ _ _s_ _ _ Indukcyjność _ _ _ _ _t_ _ _ _ Lepkość v_ _ _ _ _ _ _

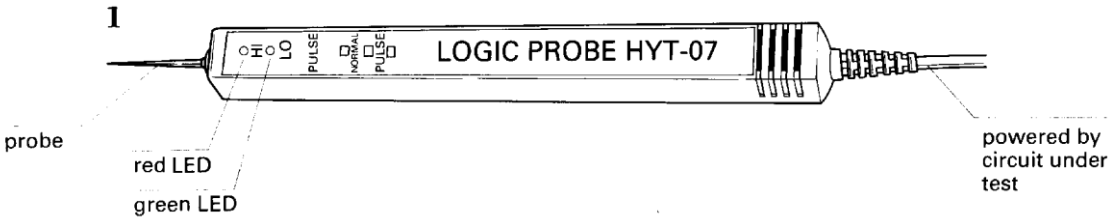
Częstotliwość _ _ _ _ _ _n_ _ Napięcie v_ _ _ _ _ _ Gęstość _ _n_ _ _ _

Rezystywność _ _s_ _ _ _ _ _ _ _ Pojemność elektryczna _ _p_ _ _ _ _ _ _ _

Task 2

How many of these instruments can you identify? Can you explain their use?

1



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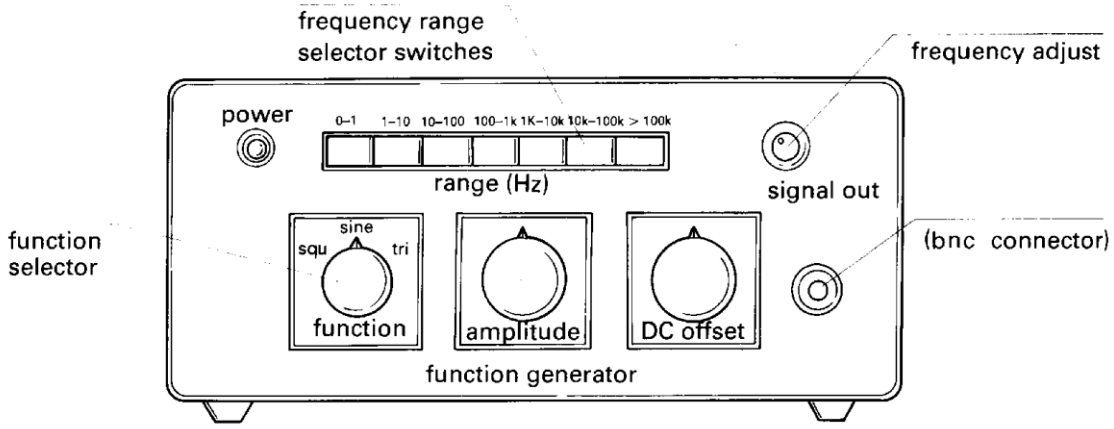
2



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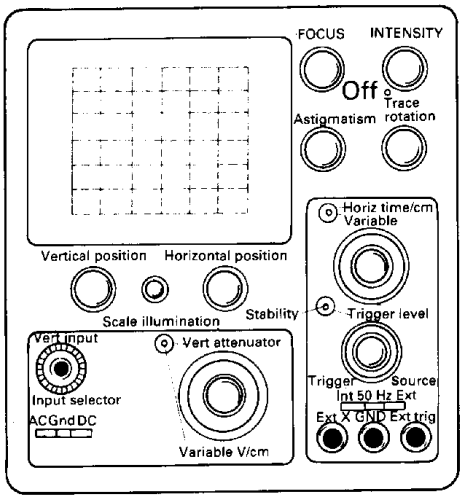

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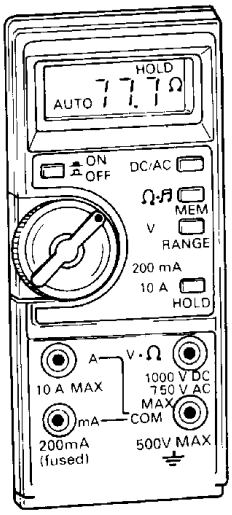

Task 3

Now match the instruments with their descriptions

.....

This instrument can be used to measure a number of different electrical quantities, such as voltage, current and resistance, i.e, it is a combined voltmeter, ammeter and ohmmeter. It can have analogue or digital displays and can be switched to different measuring ranges.

.....

This instrument is used for measuring voltage levels and pulses in digital logic circuits. When the probe is placed on the pin of a logic IC, small coloured LEDs light up to indicate if a pulse is detected or whether the pin is at a high or low logic level.

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.....

This instrument contains a triangular wave oscillator which can be switched to produce triangular, square or sine waves over a range of frequencies. It is used to test and adjust a variety of electronic equipment such as audio amplifiers. It provides a known signal which can be injected into a circuit. Often it is used with an oscilloscope so that a visual display of the waveform can be seen

.....

This instrument is used to measure fast-moving signals. It shows how a signal varies with time or relative to another signal. It uses a cathode ray tube to display the waveform of the measured signal on a screen

Task 4

Which of the instruments would you use to...

1. check a fuse
2. determine the frequency response of an audio amplifier
3. test for the presence of a control signal on the output pin of a computer chip
4. determine the value of the current through a transformer
5. measure the frequency of an oscillator

Task 5

Study these statements:

1 *The electron beam hits the screen.*
2 *The phosphor glows.*

Why does the phosphor glow? What is the relationship between statement (1) and (2)?

Statement (1) is a *cause* and statement (2) is an *effect*. We can link cause and effect statements in a number of ways. Study these ways, which use *cause* and *make*.

The electron beam hits the screen ***causing*** *the phosphor to glow.*

The electron beam hits the screen ***making*** *the phosphor glow.*

Now study these cause and effect statements:

3 *The phosphor glows.*
4 *A spot is displayed.*

The effect is in the passive. We can link cause and effect like this:

The phosphor glows ***causing*** *a spot* ***to be*** *display****ed****.*

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Link each of these cause and effect statements to make one sentence:

1 **a** A magnetic field is set up in the speaker coil.
b The coil vibrates.

2 **a** The coil pushes and pulls the speaker cone.
b Sound waves are produced.

3 **a** A voltage is applied to a quartz crystal.
b The quartz crystal expands and contracts.

4 **a** A voltage is applied to the Y-plates.
b The electron beam is deflected.

5 **a** Current flows through the filament.
b The heater glows.

Technical reading *Cathode ray oscilloscope*

Work in groups of three: **A**, **B**, and **C**.

Student A: Read *Electron gun* and take notes.
Student B: Read *Deflection system* and take notes.
Student C: Read *Phosphor screen* and take notes.

Using your notes and Fig. 1 on page 104, explain to the others in your group how your section of the CRT works. **A** should start. **B** may use Fig. 2 as part c the explanation.

Electron gun

para

A stream of electrons is released from the surface of the cathode (C) when it is heated by the heater filament. The electrons are accelerated towards the screen by a set of three positively-charged cylindrical anodes (A1, A2, A3). Each anode has a higher charge than the one before. As the electrons move towards the anodes, they pass through a hole in a negatively-charged metal disc. This disc is known as the control grid. By adjusting the intensity control on the oscilloscope, the charge on the grid can be varied. This allows the number of electrons reaching the screen, and therefore the brilliance or brightness of the spot on the screen, to be adjusted. 1

The three anodes form the electron lens. The oscilloscope focus control allows the voltage on the second anode (A2) to be varied and causes the stream of electrons to be focused into a narrow beam. If the oscilloscope has an astigmatism control, it is used to vary the voltage on the third anode (A3). This allows the shape of the spot on the screen to be adjusted to make it perfectly round. 2

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Deflection system

After leaving the electron gun, the electron beam is deflected by two pairs of parallel metal plates. The pairs of deflection plates are situated at right angles to each other. 3

The signal to be measured is amplified by the Y-amplifier in the oscilloscope, then applied to the first set of deflection plates, known as the Y-plates. This causes the electron beam to be deflected vertically in proportion to the magnitude of the input signal. 4

The oscilloscope has a timebase generator which produces a sawtooth wave output as shown in Fig. 2. 5

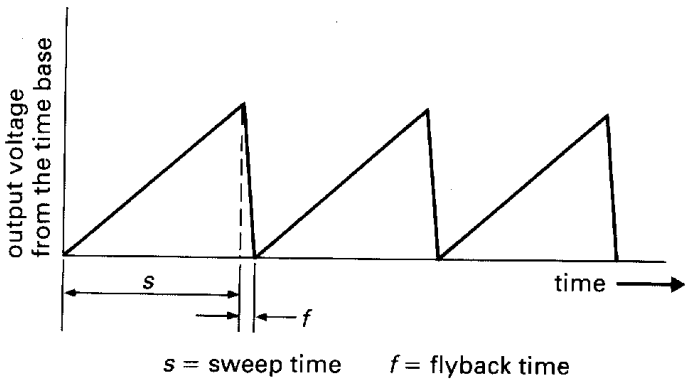

Fig. 2.

This is fed into the X-amplifier of the oscilloscope, then applied to the second set of deflection plates, known as the X-plates. This causes the electron beam to be deflected in the horizontal direction in such a way that the spot moves from left to right across the screen at a steady rate. When it reaches the right side of the screen, it rapidly returns to the left side again. This allows the screen to show how the measured signal varies with time. 6

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Phosphor screen

The X and Y deflections of the electron beam cause the signal being measured to be displayed in the form of a wave, with the magnitude of the signal being given on the vertical axis and the time variation on the horizontal axis. A piece of transparent plastic known as a graticule is attached to the front of the screen. This has a grid of horizontal and vertical lines marked on it and allows accurate measurements of the signal to be made. 7

A large build-up of negative charge could be caused by the electron beam hitting the phosphor screen. To help prevent this, the inside of the CRT, between the deflection system and the screen, is coated with a carbon compound known as Aquadag. This is attached to the high voltage anode (A3) to provide an escape path for the excess electrons. 8

The CRT is enclosed in a metal casing made from an alloy of nickel, known as mu-metal. This has a very high magnetic permeability and prevents external magnetic fields from causing unwanted beam deflections. 9

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