DATE	COURSE/YEAR/GROUP	STUDENT'S NAME

UNIVERSITY OF PLYMOUTH

Department of Communication & Electronic Engineering

EXPERIMENT PF1 **Standard Station Type - Room 304**

INSTRUMENT FAMILIARISATION

Aim: To become familiar with:- basic instruments, wiring, taking readings, and the concepts of: voltage, current and resistance.

The laboratory will involve the use of a number of general purpose instruments. Typical examples are the Cathode Ray Oscilloscope (C.R.O.), Power Supply (P.S.U.), Function Generator (F.G.) and Digital Multimeter (D.M.M.)

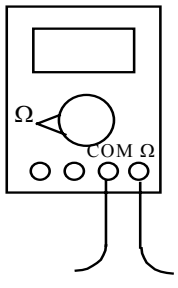
Introduction

1. Measure the resistance of R_1 to R_5 individually and record the results in table 1. [Use the Ω switch position on the multimeter and note if the display says kΩ, i.e. times reading by 1000.] NB Do not use the power supply.

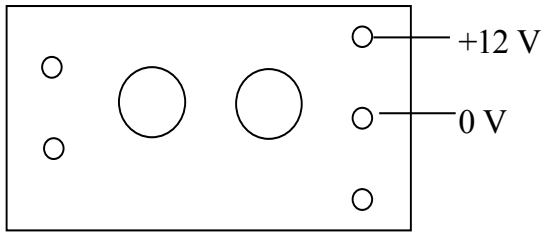
R_1	R_2	R_3	R_4	R_5

Table 1.

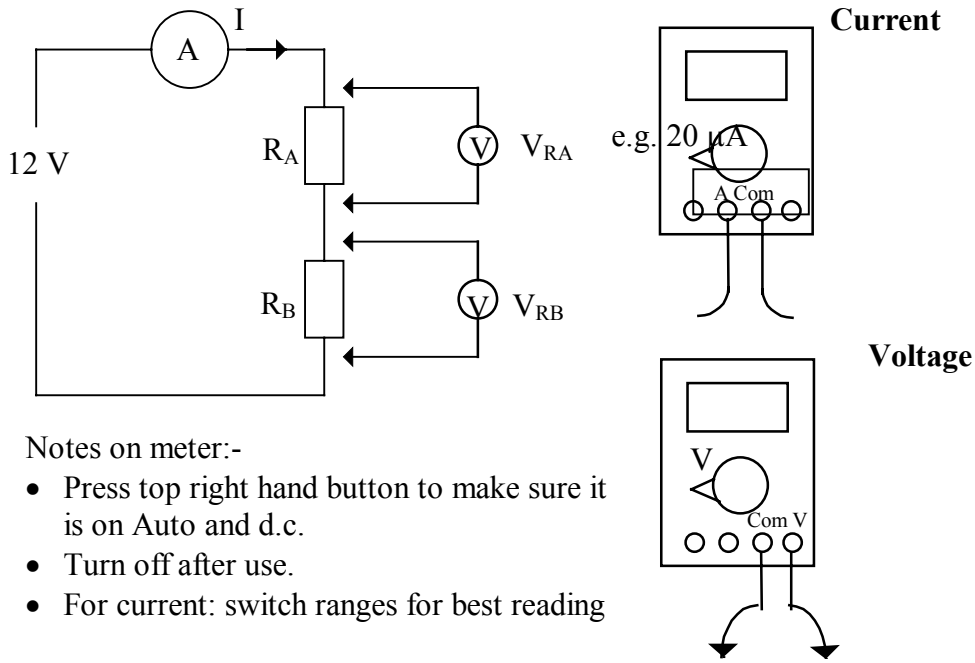
Resistance on the multi-meter



Power Supply



2. Connect up the circuit (over) using the power supply (see above) set to give 12 V. Fill in table 2 (over) i.e. measure the current and voltages. N.B. Use $R_2 = R_A$ and $R_3 = R_B$ for the first set of measurements, then $R_4 = R_A$ and $R_5 = R_B$ for the second set of readings.



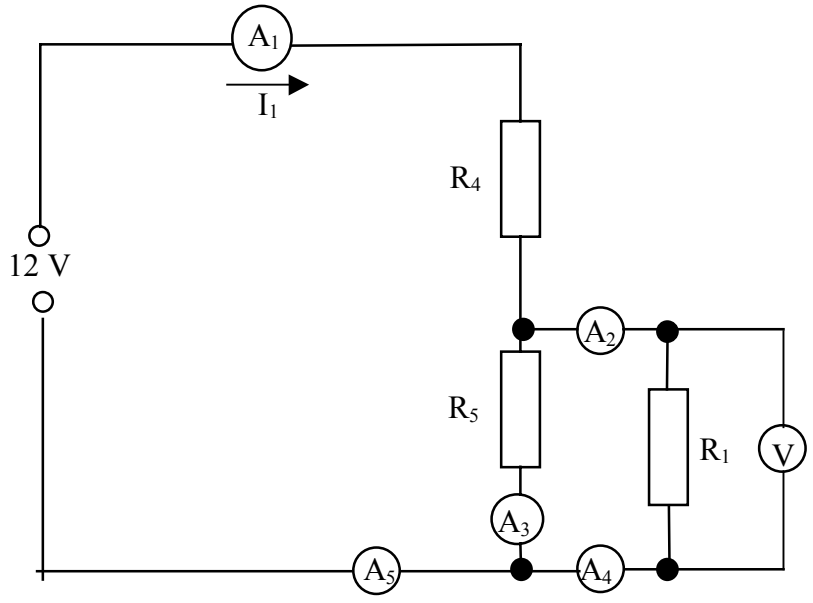
Notes on meter:-

- Press top right hand button to make sure it is on Auto and d.c.
- Turn off after use.
- For current: switch ranges for best reading

V_{R2}	V_{R3}	I_{MEAS}	I_{CALC} $=V/(R_2+R_3)$	V_{R4}	V_{R5}	I_{MEAS}	I_{CALC} $=V/(R_4+R_5)$

Table 2. NB mA = x 0.001 A μA = x 0.000001 A

3. Connect up the following circuit with no meter included, then use the multimeter to take the readings required, by introducing the meter at one position at a time.
   NB Think when you change from current to voltage measurement.



V_{R4}	V_{R5}	V_{R1}	I_1	I_2	I_3	I_4	I_5

Comments and Calculations

1. Does V measured = V_{CALC}? (N.B. you need to calculated the effect of R_1 and R_5 in parallel (i.e. new resistance value) and then use this resistor value in the potential divider formula.

Your comments:-

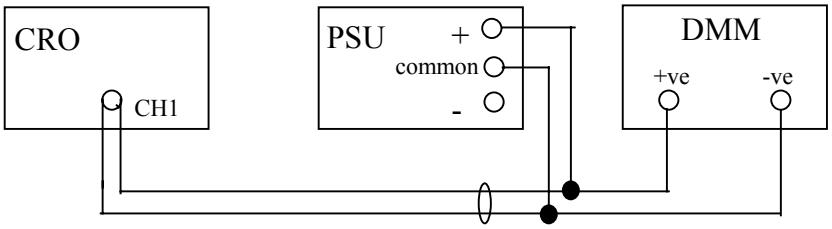
2. Does Kirchoff's current law hold? i.e. $I_4 + I_3 + I_5 = 0$ (N.B. you need to define one circuit direction as negative). Also does $I_1 = I_5$ and $I_2 = I_4$?

Your comments:-

INSTRUMENT APPLICATIONS

Section 1:

Connect up the circuit shown below.



Set the DMM to the d.c. voltage range **before switching on the PSU.**

Switch on the CRO and adjust the intensity and focus controls to give a sharp and not too bright trace on the screen. (Ensure that the Bright Line is ON). Select CH1 only, with TRIG on LINE, and switch input to GND. Adjust trace to centre of the screen and then change input to DC. Switch input to 2 V/DIV and timebase TIME/DIV to 0.2 ms. ENSURE THAT THE INPUT AND TIMEBASE CONTROLS ARE SET TO THE 'CALIBRATE' POSITION.

Using each of the PSU outputs in turn, measure the maximum and minimum output voltages using both the CRO and DMM.

	CRO		DMM	
OUTPUT	MAX(V)	MIN(V)	MAX(V)	MIN(V)
1				
2				
3				

Section 2:

Replace the PSU with the Function Generator (F.G.), using the 50 Ω output, and add the frequency meter to the circuit. Change to a.c. voltage on the DMM and select SINE output on the F.G. Set the signal to 8 V peak-to-peak, at a frequency of 1 kHz, using the CRO display, adjusting the trigger level to obtain a steady picture. Complete the table of readings below.

CRO		DMM	DMM	Ratio	DMM
V p-p (V)	Freq (Hz)	Freq (Hz)	V_{rms} (V)	V_{peak}/V_{rms}	V_{mean} (V)

Change the F.G. to SQUARE and TRIANGULAR outputs and without changing the o/p level, note the peak-to-peak voltage in each case.

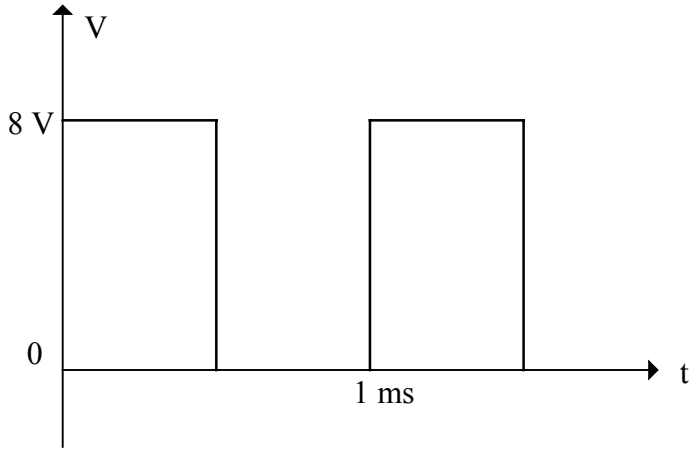
Using any convenient waveform, change to **-20 dB** output and note the effect on the output waveform.

Switch Position	Vp-p (V)
0 dB output	
-20 dB output	

Return to 0 dB output and now **select x5** on the timebase. What is the effect on the waveform?

Notes:

Next display the SQUARE WAVE as before at 9 V p-p and 1 kHz. Press the 'offset' button on the F.G. and observe the change in the waveform as the d.c. offset level is changed. Using this control, create the waveform shown over.



Measure the d.c. level in this waveform using the DMM. V_{dc} = V.

On the CRO note the effect of switching between **DC and AC input.**

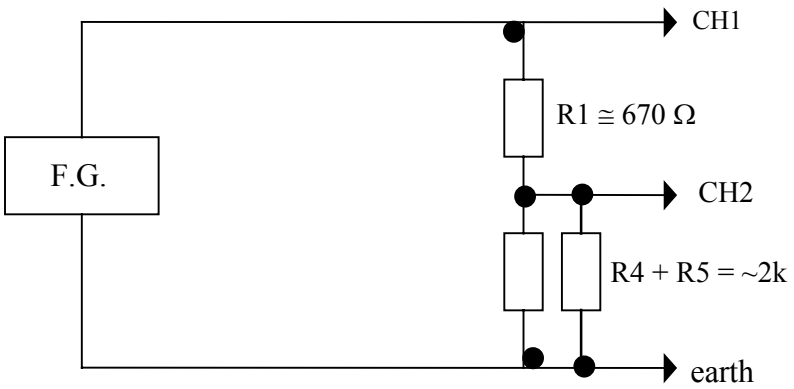
RESULT: When the CRO input is switched from DC to AC the effect on the waveform is:

Having established the effect of switching from DC to AC input, estimate the d.c. level of the waveform using the CRO display.

V_{dc} estimated from the CRO =

Section 3: Dual Trace Display

Switch CRO MODE to Dual, set up a 10 V peak-to-peak, 5 kHz sinusoidal waveform on the F.G. and display on the CRO. Apply the signal to the potential divider circuit shown below.



Is the waveform displayed on CH2 as you would expect? YES/NO

Measure the peak-to-peak voltage on CH2. Vp-p = V

Calculate the expected peak-to-peak voltage on CH2. Vp-p = V

Now, **select INV** on the CH2 input. Note the result.

Effect on CH2 waveform of selecting INV is ……..

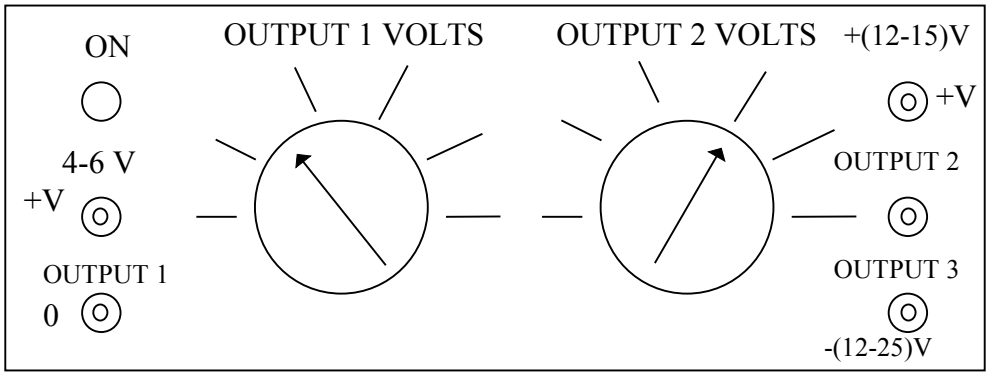
Finally, **select ADD** and record the resulting waveform below.

What is the waveform that has been recorded? Confirm your decision by calculation:

Calculations:

Appendix: Instrument Details

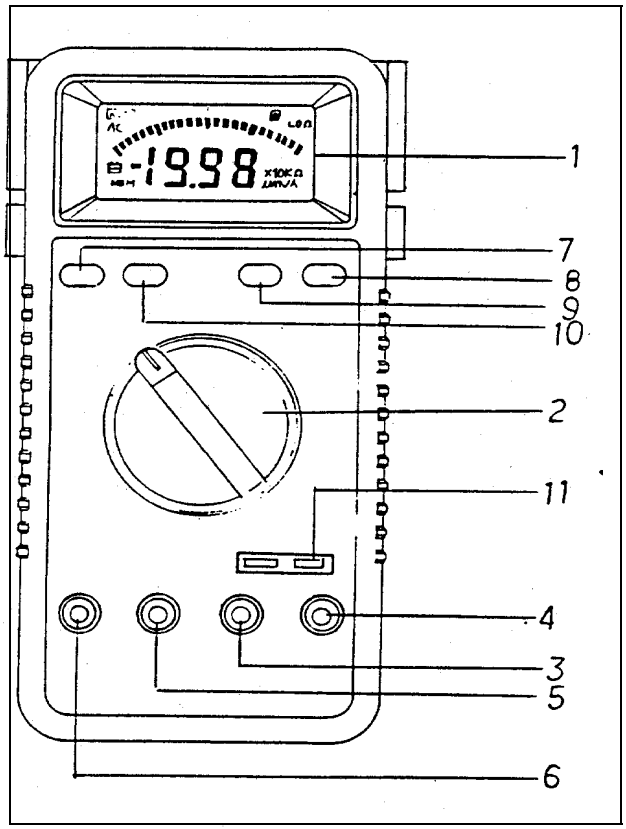
1. **Power Supply**



Note the mains switch for this instrument is on the backpanel.
The left side, OUTPUT 1, provides a d.c. voltage adjustable between 4 and 6 volts, this is intended for work using logic circuits.

The right side provides a balanced dual rail output, OUTPUT 2 AND OUTPUT 3, adjustable between ±(12 to 15) volts. The centre terminal is at 0 V and the two other terminals provide +ve and -ve outputs relative to this. This type of output is typically used with operational amplifier circuits.

2. **Digital Multimeter**



Label/ describe the function of the parts numbered 1 – 8 below: (ignore 9 – 11)

The digital multimeter provides selections for the measurement of (i) a.c. and d.c. current, (ii) a.c. and d.c. voltage, frequency and (iii) resistance. The functions are selected by the appropriate buttons along with the range required.

NOTES:

a) This type of meter is intended to measure **magnitudes** of waveforms or components. For example the value of the d.c. voltage applied to a circuit or the ohmic value of a resistor. It does not give any indication of the shape of the waveform.

b) Always ensure that the correct function is selected BEFORE connecting the meter into a circuit as an incorrect function could lead to short circuits, e.g. an ammeter connected across a supply when it is intended to measure voltage.

c) When using the DMM to measure the resistance of a component, the component must be isolated from any supplies, and in some cases, from the rest of the circuit.

3. Cathode Ray Oscilloscope

The CRO is used to display repetitive time varying waveforms. In addition to seeing a voltage/time display, measurements of voltage and/or time may be obtained from the CRO. For these measurements to be meaningful, the instrument controls **must** be set to the CALIBRATE positions.

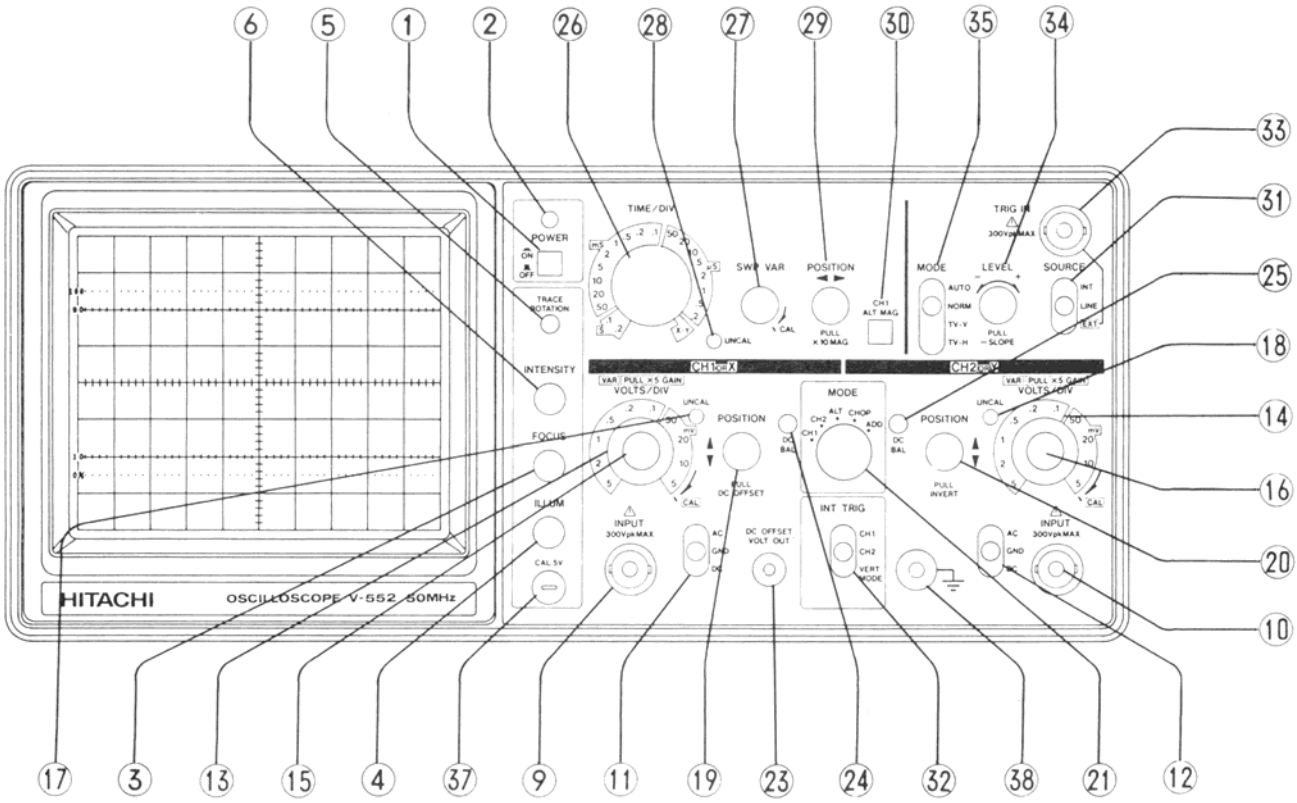


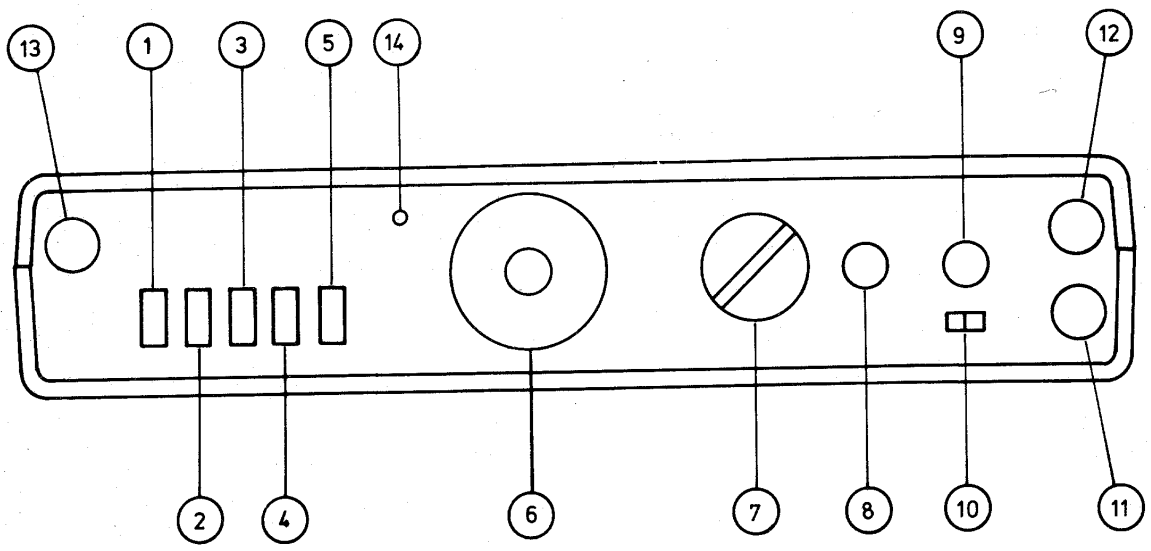
Fig. 4-1 Front panel (This panel is V-552)

The basic CRO may be divided into 4 main sections.

i. The display area with 'intensity' and 'focus' controls.
ii. The vertical control section with the 'inputs', 'input sensitivity' selection in VOLTS/CM, 'variable sensitivity' including the 'CAL' setting, 'vertical shift' and MODE' selection which determines whether one, two or both channels are displayed.
iii. The horizon section with the 'timebase' selection, 'variable sweep' and X-axis shift controls.
iv. The trigger section, which selects which input channel will be used to trigger the horizontal sweep, and the 'trigger level' which determines the point on the waveform where triggering will commence.

Identify the four areas and mark them on the oscilloscope front panel on the previous page.

4. **Function Generator**



Label the parts on the diagram:

A Signal Generator is capable of producing a sinusoidal alternating signal of varying magnitude and frequency. The Function Generator shown here serves the same purpose but can additionally produce square and triangular waveforms, with an additional d.c. offset if required. The functions are selected using the buttons and magnitude adjusted by the o/p level control. Frequency selection requires setting a switched control for the frequency band, with final adjustment using the rotary frequency control.