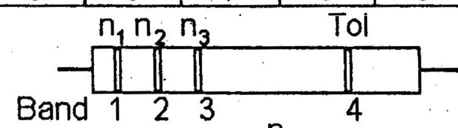
BASIC ELECTRONICS LABORATORY
EXPERIMENT NO: 1
MEASUREMENT OF RESISTANCE, CLASSIFICATION OF CAPACITORS DIODE TESTING

A Note On Reading Resistor Values: The colour bands on resistors are used to indicate the nominal values of their resistance and the permitted tolerance on that value. The first three bands (closest together) give the value of the resistor in ohms (Ω). The band at the end of the resistor indicates the first significant digit (n_1) and the next band indicates the second digit (n_2). The third band indicates the number of zeros following these two digits (n_3). The bands are colour coded as follows:

Colour	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White
Digit	0	1	2	3	4	5	6	7	8	9

A red fourth band means the resistor's value will be within 2% of the stated value, gold 5%, and silver 10%, Absence of the fourth band indicates a ±20% tolerance.



$$R = n_1 n_2 \times 10^{n_3} \pm \text{Tol } \Omega$$

A Note On Reading Capacitor Values: ***Big capacitors*** are polarized. The terminal - (+) must be at least as negative (positive) as the other terminal. These have values marked in μF.

Smaller Capacitors: Tantalum: These are often coloured cylinders. Mylar: These are yellow cylinders made of long coils of metal foils separated by thin dielectrics. Fat rectangular shaped capacitors are often made of Metallized Polyster film. Ceramic: These are often disc shaped.

While reading small capacitor values one must remember that in electronics these are in the range pF- μF (a few pF to a few μF). Some examples of the markings and the corresponding values are given below.

Markings	A100	10KH	475K	475M	.01M	.1MFD	473J
Read as	100pF ±20%	10 KpF ±20%	47×10^5pF ±10%	47×10^5pF ±20%	.01μF ±20%	0.1μF ±20%	0.047μF ±5%
Markings	4R7μ	560M	101K	4k7	22n	0.1	Colour band
Read as	4.7μF ±20%	560pF ±20%	10×10^1pF ±10%	4.7×10^3pF ±20%	22nF ±20%	0.1μF ±20%	Value read from top to bottom.

I. **Experiment:** **(i)** Identify the resistors in the board. **(ii)** Read their values. **(iii)** Use a multimeter in the 'Resistance' mode to measure these values. In case of non autoranging multimeters use the range that gives the maximum accuracy of the readings.

CAUTION: *No voltage other than that due to the multimeter should be present across the resistors while measuring resistance.*

(iv) Identify the capacitors in the board. **(v)** Read their values. You may also measure the capacitance with your multimeter if it has the capacitance measuring mode.

(vi) Identify the inductor in the board.

A Note On Ground (sometimes called Earth): Symbol: ⏚ (sometimes ⏚). This term indicates a **'common reference'** point in the circuit. It does not necessarily mean that it actually goes to earth.

P.T.O.

ADDITIONAL NOTE ON READING CAPACITOR VALUES:

Large capacitors have the value printed plainly on them, such as 10µF (Ten Micro Farads) but smaller disk types along with plastic film types often have just 2 or three numbers on them?

First, most will have three numbers, but sometimes there are just two numbers. These are read as Pico-Farads. An example: 47 printed on a small disk can be assumed to be 47 Pico-Farads (or 47 puff as some like to say)

Now, what about the three numbers? It is somewhat similar to the resistor code. The first two are the 1st and 2nd significant digits and the third is a multiplier code. Most of the time the last digit tells you how many zeros to write after the first two digits, but the standard has a couple of curves that you probably will never see. But just to be complete here it is in a table.

Third digit	Multiplier (this times the first two digits gives you the value in Pico-Farads)
0	1
1	10
2	100
3	1,000
4	10,000
5	100,000
6 not used	
7 not used	
8	.01
9	.1

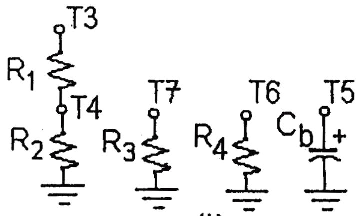
Now for an example: A capacitor marked 104 is 10 with 4 more zeros or 100,000pF which is otherwise referred to as a .1 µF capacitor.

Most kit builders don't need to go further, but I know you want to learn more. Anyway, Just to confuse you some more there is sometimes a tolerance code given by a single letter. I don't know why there were picked in the order they are, except that it kind of follows the middle row of keys on a typewriter.

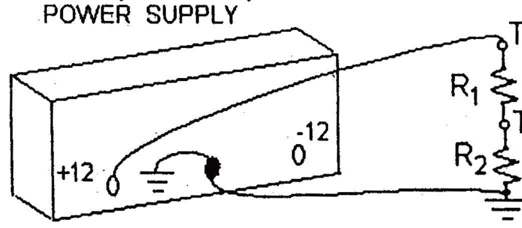
So a 103J is a 10,000 pF with +/-5% tolerance

Letter symbol	Tolerance of capacitor
D	+/- 0.5 pF
F	+/- 1%
G	+/- 2%
H	+/- 3%
J	+/- 5%
K	+/- 10%
M	+/- 20%
P	+100% ,-0%
Z	+80%, -20%

II. Experiment: **(i)** In the board identify the circuit shown in Fig.(i). *Question:* What is the resistance between terminals T3 and T7? Measure this resistance and thereby verify that the bottom ends of R2 and R3 are electrically joined. Will the resistance between T3 and T7 differ if the ground points are instead actually connected to some point in the planet Earth?



(i)

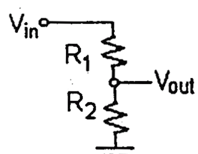


(ii)

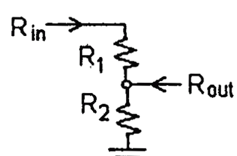
(ii) Make the **voltage divider** connection, Fig.(ii). Using the multimeter's appropriate voltage range (*CAUTION*: in case of non auto-ranging multimeter, begin from the highest range and then switch to the range which gives maximum accuracy) measure the applied voltage V_{T3} at T3 (i.e. the voltage between T3 and ground). Verify that the voltage V_{T4} at T4 is given by

$$V_{out} = V_{in} \times R_2/(R_1+R_2), \qquad \text{where } V_{in} = V_{T3} \text{ and } V_{out} = V_{T4}.$$

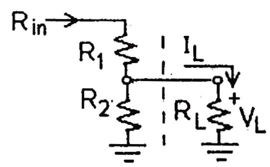
Thus Fig.(ii) corresponds to Fig.(iii) with V_{in}, V_{out} replaced by V_{T3}, V_{T4} respectively.



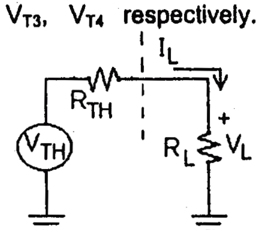
(iii)



(iv)



(v)



(vi)

Thevenin Model Of The Voltage Divider: *Problem*: What are R_{in}, R_{out} in Fig.(iv)? The voltage divider can be viewed in different ways, Figs(iii)- (vi). Figure(v) and Fig.(vi) are general ways of viewing Fig.(iii). Figure(iii) is a special case of Fig.(v) or Fig.(vi) with $R_L = \infty$, i.e. no load case.

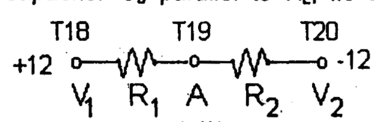
R_{in} in Fig.(iv) and Fig.(v) is the resistance seen looking into the input terminal. Thus in Fig.(ii) and Fig.(iii) $R_{in} = (R_1+R_2)$, whilst in Fig.(v) $R_{in} = R_1 + (R_2 \parallel R_L)$.

R_{out} is the resistance seen by the load R_L. Assuming the voltage source is an ideal voltage source (source resistance= 0 Ω), $R_{out} = R_1 \times R_2/(R_1+R_2) = R_1 \parallel R_2$.

The Thevenin model of the voltage divider is a voltage source V_{TH} ($=V_{out}$) in series with a source resistance R_{TH} ($=R_{out}$), Fig.(vi).

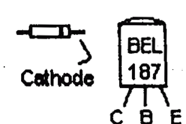
III. Experiment: **(i)** Calculate the voltage V_L and the current I_L in Fig.(v) using Ohm's law and in Fig.(vi) when **(a)** $R_L = R_3$ (by connecting T7 to T4 , Fig.(i)), **(b)** $R_L = R_4$ (by connecting only T6 to T4), **(c)** $R_L = R_3 \parallel R_4$ (by connecting T6&T7 to T4), Compare your calculations with direct measurements of V_L. **(ii)** Repeat (a) to (b) above, with capacitor C_b parallel to R_L, i.e by connecting in addition T5 to T4.

(iii) Make the connections shown in Fig.(vii) by applying +12V between T18 & ground and –12V between T20 & ground. V_A at T19 and compare with that given by $V_A = (V_1 \times R_2 + V_2 \times R_1)/(R_1+R_2)$.

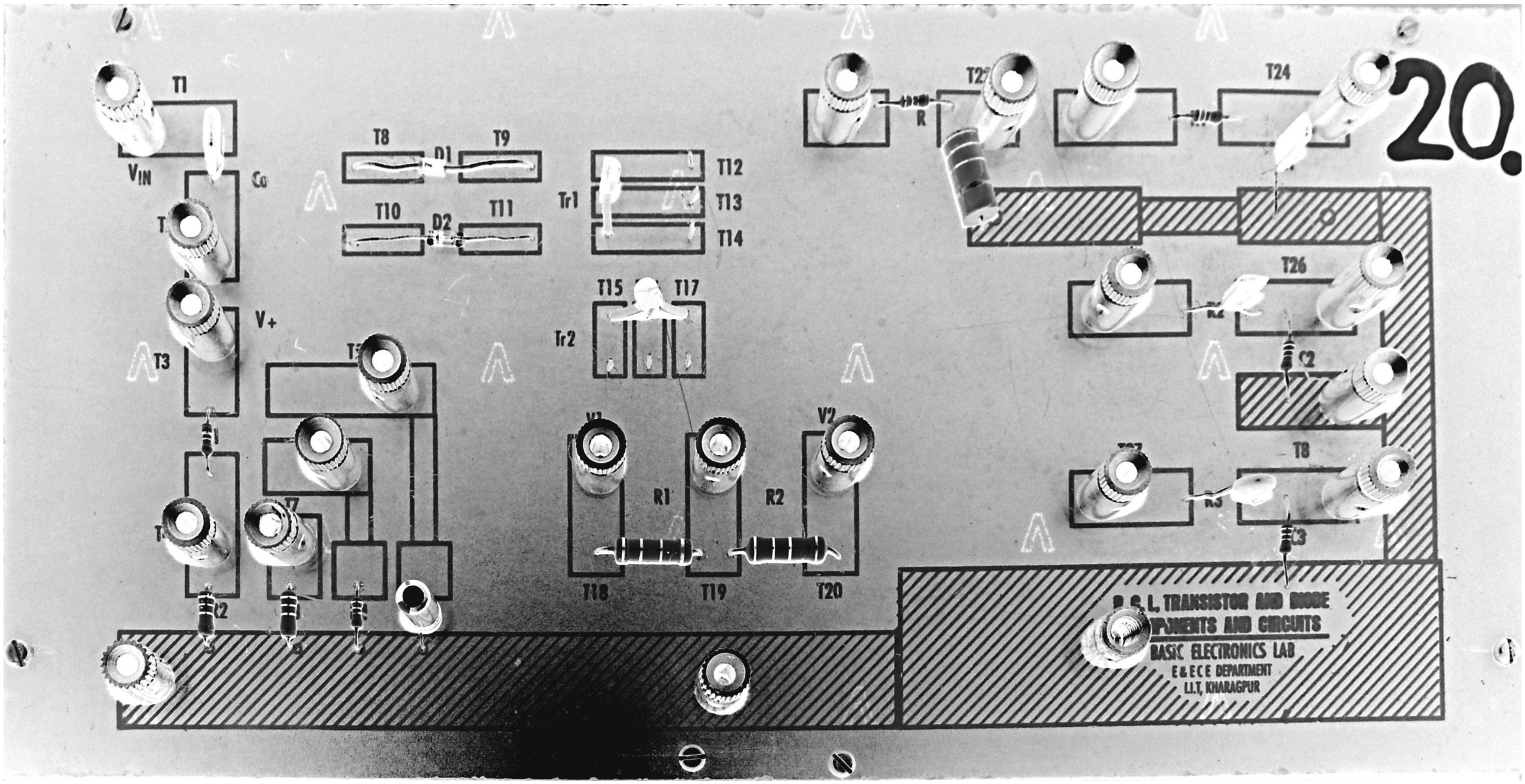


(vii)

IV. Active Devices: **(i)** Locate the diodes D_1, D_2 and the transistors TR1, TR2 in the board. Identify their terminals. **(ii)** Using the multimeter in the 'Diode-check' position determine the quality and thereby the semiconductor material type for each of these devices. **(iii)** Verify that for transistors the forward bias diode drops $|V_{BE}| > |V_{BC}|$. Thus distinguish between the C and E terminals. **(iv)** Measure h_{FE} of the transistor if this measurement facility is available with your multimeter.



(viii)



- Discrete components (R, C, diodes, transistors) on left-hand-side of the measurement-board are meant for Experiment 01
- R-C, C-R, R-L circuits on the right-hand-side are meant for Experiment 02