A+B \ C+D	0+0	0+1	1+1	1+0
	m_0	m_1	m_3	m_2
	m_5	m_6	m_7	m_8
	m_{12}	m_{13}	m_{15}	m_{14}
	m_8	m_{10}	m_{11}	m_9

4 - variable

A \ B+C	0+0	0+1	1+1	1+0
0	m_0	m_1	m_3	m_2
1	m_4	m_5	m_7	m_6

3 variable

A \ B	0	1
0	m_0	m_1
1	m_2	m_3

2 variable

working for plotting k-map

let $Y(A,B,C) = AB + A'BC$

convert Y into canonical SOP

$Y = AB(C+C') + A'BC$

$= ABC + ABC' + A'BC$

$= 111 \quad 110 \quad 011$

$m_7 \quad m_6 \quad m_3$

A \ BC	00	01	11	10
0	0	0	1	0
1	0	0	1	1

Lecture 37

POS f^n

$Y = (A+B) \cdot \bar{A}$

convert Y into canonical POS

$= A+B \cdot \bar{A} + B \cdot \bar{B}$

$= (A+B) \cdot (\bar{A}+B)(A+\bar{B})$

$0\,0 \quad 1\,0 \quad 1\,1$

A \ B	0	1
0	0	1
1	0	0

A \ BC	0+0	0+1	1+1	1+0
0	0	0	0	0
1	1	1	1	1

$Y(A,B,C,D) = (A+B+C+D)\cdot(A+\bar{B}+C)\cdot(A+\bar{B}+\bar{C}+\bar{D})$

Canonical pos form

$= (A+B+C+D)\cdot(A+\bar{B}+C)+(D\bar{D})\cdot(A+\bar{B}+\bar{C}+\bar{D})$

$= (A+B+C+D)\cdot(A+\bar{B}+C+D)\cdot(A+\bar{B}+C+\bar{D})(A+\bar{B}+\bar{C}+\bar{D})$ (1)

0000   0100   0101   0111

A+B \ C+D	0+0	0+1	1+1	1+0
0+0	0	1	1	1
0+1	0	0	0	1
1+1	1	1	1	1
1+0	1	1	1	1

A \ BC	00	01	11	10
0	1	1	1	1
1	1	1	1	1

Sop

Sop

$Y=1$ $Y=0$ if 0 is in all cells

A \ B+C	0+0	0+1	1+1	1+0
0	0	0	1	1
1	0	0	1	1

Pos

$Y=B$

A \ BC	00	01	11	10
0	1	1	0	0
1	1	1	0	0

$Y=\bar{B}$

A+B \ C+D	0+0	0+1	1+1	1+0
0+0	0	0	0	0
0+1	0	1	1	1
1+1	0	1	1	1
1+0	0	1	1	1

$Y=(C+D)\cdot(A+B)$

AB \ CD				
	1	0	0	1
	1	0	0	1
	1	0	0	1
	1	1	1	1

$Y=\bar{D}+A\bar{B}$

$Y(A,B,C,D) = \Sigma m(0,2,4,5,6,7,12,15)$ — ①

$Y(A,B,C,D) = \Pi M[1,3,5,7,9,11,18]$ — ②

①

AB \ CD	00	01	11	10
00	1	0	0	1
01	1	1	1	1
11	0	0	0	0
10	1	0	1	0

AB \ CD	00	01	11	10
00	1	0	0	1
01	1	0	0	1
11	1	0	0	1
10	1	1	1	0

$Y(A,B,C) = \Sigma m(0,1,3,5,7)$

A \ BC	00	01	11	10
0	1	1	1	0
1	0	1	1	0

$Y = \bar{A}\bar{B} + C$

$Y(A,B,C,D) = \Sigma m(0,1,3,5,7,14,15)$

AB \ CD	00	01	11	10
00	1	1	1	0
01	0	1	1	0
11	1	0	1	0
10	0	0	0	0

$\to \bar{A}D$

$\to BCD$

$\bar{A}\bar{B}\bar{C}$

$AB\bar{C}\bar{D}$

$Y = \bar{A}\bar{B}\bar{C} + \bar{A}D + AB\bar{C}\bar{D} + BCD$

Lecture 35

$Y(A,B,C,D) = \Sigma m(0,3,5,7,9,11,12,14,15)$

SOP representation

AB \ CD	00	01	11	10
00	1	0	1	0
01	0	1	1	0
11	1	0	1	1
10	0	1	1	0

$\bar{A}\bar{B}\bar{C}\bar{D}$

$\bar{A}BD$

$AB\bar{D}$

CD

$Y = \bar{A}\bar{B}\bar{C}\bar{D} + \bar{A}BD + AB\bar{D} + CD$

$= \Pi M(1,2,4,6,8,10,13)$

POS

A+B \ C+D	0+0	0+1	1+1	1+0
0+0	1	0	1	0
0+1	0	1	1	0
1+1	1	0	1	1
1+0	0	1	1	0

$Y(A,B,C,D) = \Sigma m(0,2,6,7,8,9)$
$d(10,12)$

d = don't care

X = 0 or 1

AB \ CD	00	01	11	10
00	1			1
01			1	1
11	d			
10	1	1		d

$A'B'D'$

$A'CD'$

$A'BC$

$AB'C'$

$A'C'D'$

$AB'D'$

$Y = AB'C' + A'C'D' + A'B'D' + A'CD' + A'BC + AB'D$

$Y(A,B,C,D) = \prod M(0,1,3,5,7,9,11,12,13) \cdot d(2,14,15)$

$M_0\ M_1\ M_3\ M_5\ M_7\ M_9\ M_{11}\ M_{12}\ M_{13}$ $\quad d_2\ d_{14}\ d_{15}$

A+B \ C+D	0+0	0+1	1+1	1+0
0+0	0	0	0	d
0+1	1	0	0	1
1+1	0	0	d	d
1+0	1	0	0	1

← A+B $\quad Y = (A+B)\cdot(A'+B)\cdot\bar{D}$

← A'+B'

D'

Lecture 36

Electronic Instruments

1. Multimeter
2. Electronic voltmeter
3. Cathod ray oscilloscope (CRO)

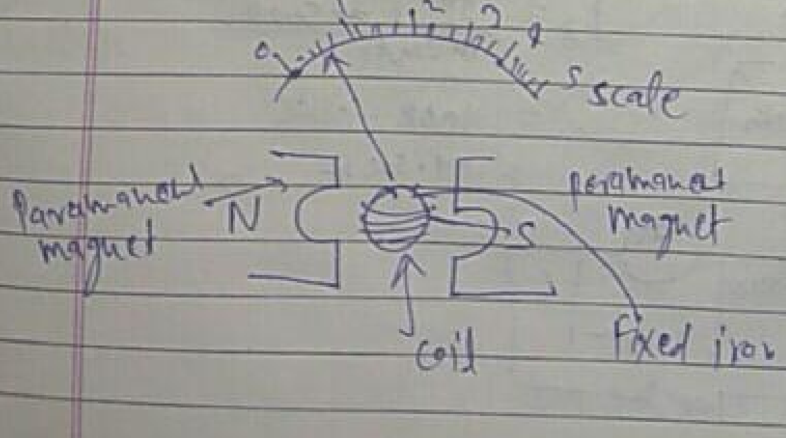
Resistance, I, V freq etc

Multimeter

Multi → (many)

Resistance, current, voltage measure by multimeter (ac & dc)

PMMC meter or d Arsonval meter or galvanometer



T_d = Deflection torque

$T_d \propto I$

T_r

Deflection torque

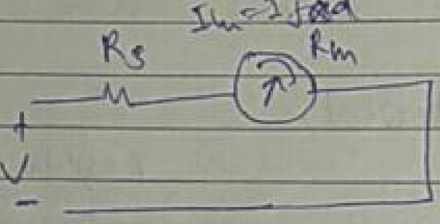
$T_d = T_r$

$T_d \propto I \qquad T_r \propto \theta$

$$\boxed{I \propto \theta}$$

Voltage can be measure by using PMMC or Galvanometer

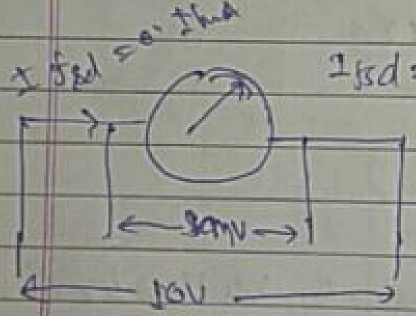
Multimetor $\longrightarrow$ PMMC



R_m = internal resistance of PMMC

$I_m = I_{fsd}$
= full scale deflection current

R_s = series resistance



$I_{fsd} = 0.1mA$

$R_m = 500\Omega$

$V = I_{fsd} \times R_m$

$= 0.1mA \times 500\Omega$

$= 50mV$

$V = I_m \times R_s + I_m R_m$

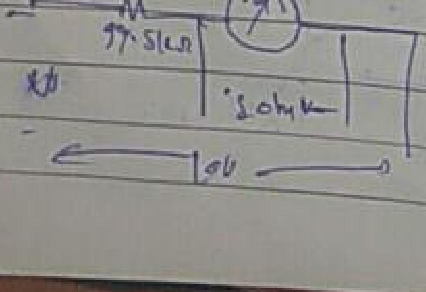
$\frac{V}{I_m} = R_s + R_m$

$$\boxed{R_s = \frac{V}{I_m} - R_m}$$

$R_s = \frac{10}{0.1mA} - 500\Omega$

$= 100k - .5K$

$= 99.5K\Omega$



PMMC $I_{fsd} = 0.1mA$

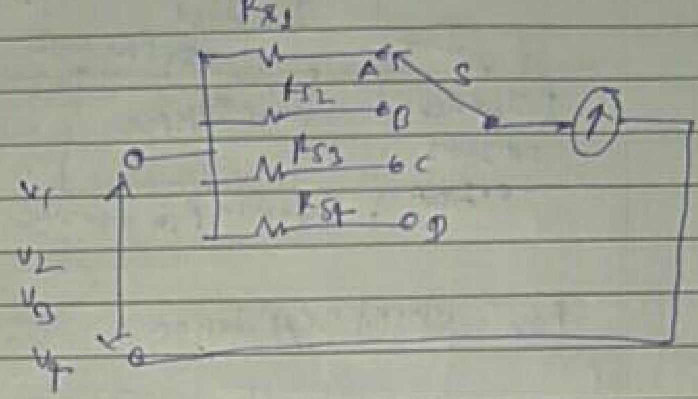
$R_m = 500\Omega$

0 – 10V R_{s1}

0 – 50V R_{s2}

0 – 100V R_{s3}

0 – 500V R_{s4}



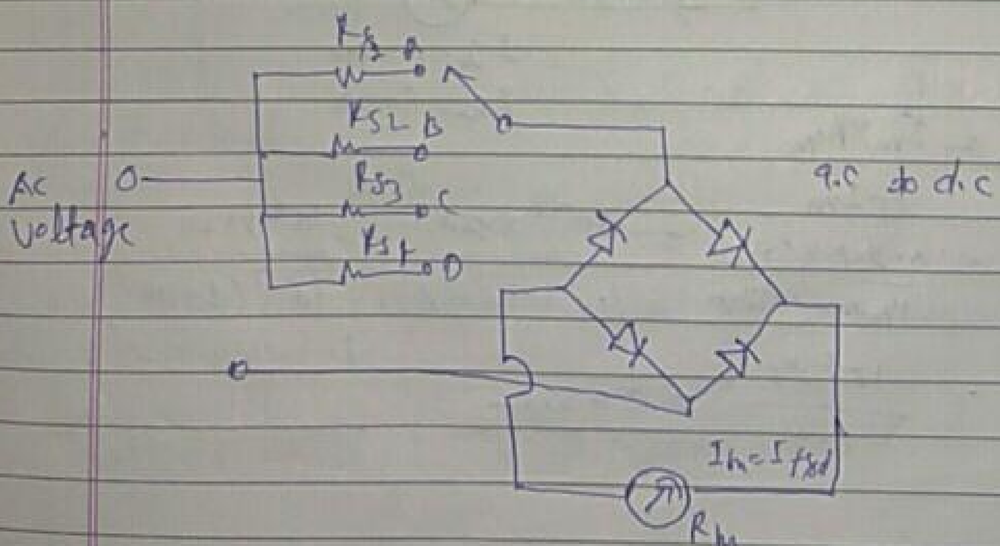
$R_{s1} = \frac{V}{I_m} - R_m$

$= \frac{10}{0.1mA} - 500\Omega = 99.5K\Omega$

$R_{s2} = \frac{50}{0.1mA} - 500\Omega = 499.5K\Omega$

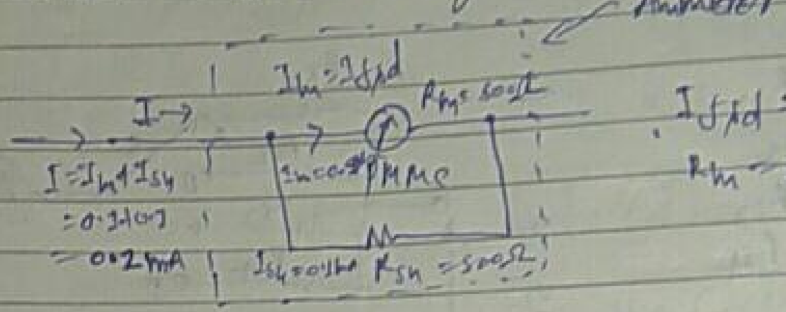
$R_{s3} = \frac{100}{0.1mA} - 500 = 999.5K\Omega$

$R_{s4} = \frac{500}{0.1mA} - 500 = 4999.5K\Omega$



rms value of dc presence

current measurment using PMMC



$I_{fsd} = 0.1mA$

$R_m = 500\Omega$

R_{sh} = shunt resistance

$I_m \times R_m = I_{sh} \times R_{sh}$

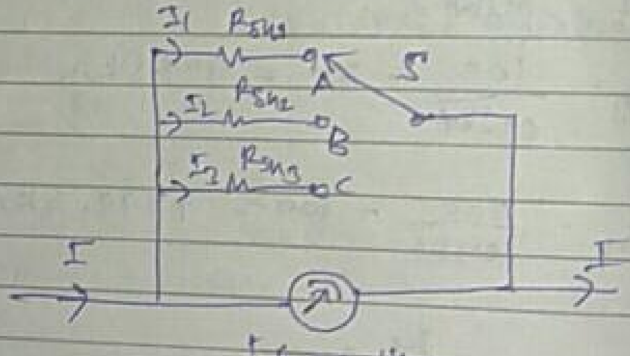
$$\boxed{R_{sh} = \frac{I_m \times R_m}{I - I_m}}$$

$$R_{sh} = \frac{0.1mA \times 500}{0.2mA - 0.1mA} = 500\Omega$$

$I_1 = 1mA$

$I_2 = 10mA$

$I_3 = 100mA$



$I_m = 0.1mA$

$R_m = 500\Omega$

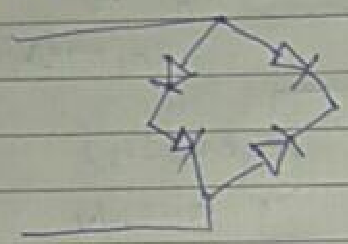
$$R_{sh1} = \frac{I_m \times R_m}{I_1 - I_m}$$

$$= \frac{0.1mA \times 500\Omega}{1mA - 0.1mA} = \frac{10^{-4} \times 500}{(10^{-3} - 10^{-4})A} = \frac{10^{-4} \times 500}{10^{-3}(1 - 10^{-1})}$$

$$= \frac{10^{-1} \times 500}{0.9} = 55.55\Omega$$

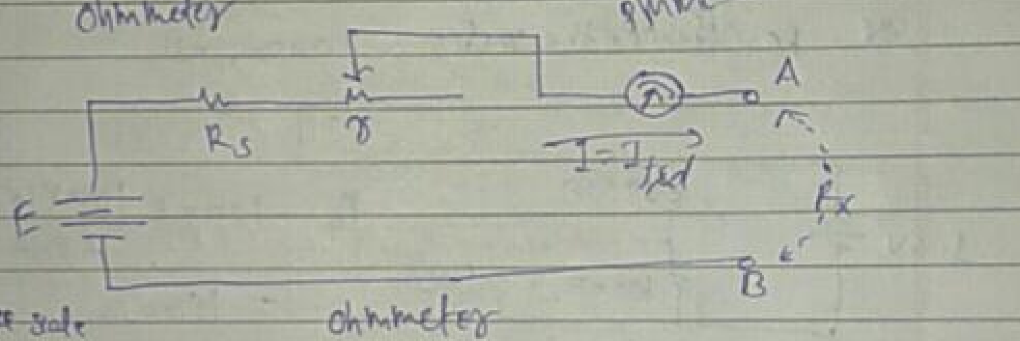
$$R_{sh_2} = \frac{I_m \times R_m}{I_2 - I_m} = \frac{0.1mA \times 500\Omega}{10mA - 0.1mA} = 5.05\Omega$$

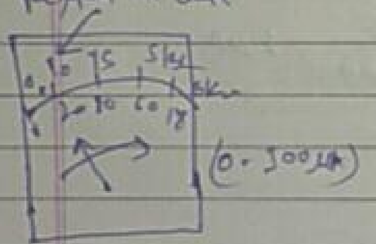
$$R_{sh_3} = \frac{I_m \times R_m}{I_3 - I_m} = \frac{0.1mA \times 500}{100mA - 0.1mA} = 0.50\Omega$$



Lecture 37

Ohmmeter





Resistance of scale of multimeter

Multimeter sensitivity

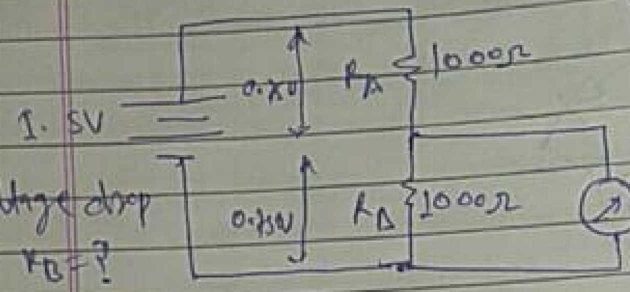
Greater the sensitivity → Greater is the accuracy of measurement

$$\text{Sensitivity} = \frac{1}{I_{fsd}} = \Omega/\text{volt}$$

$$= \frac{1}{C.S}$$

$\boxed{A}$ 1000kΩ/V

$\boxed{B}$ ~~5000kΩ/V~~



voltage drop at r_B = ?

$V_{R_A} = V_{R_B} = 0.75V$

20,000Ω/V (0-1V range)

$R_m = 1k\Omega$

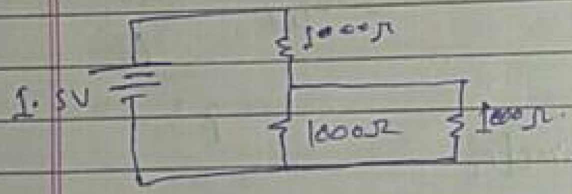
1000Ω/V

0-1V range

Q. Sensitivity of the meter = 1000Ω/V

∴ Resistance of the meter $= 1000\frac{\Omega}{V} \times 1V$

$= 1000\Omega$



$R_T = 1000 + \frac{1000 \times 1000}{2000}$

$= 1500\Omega$

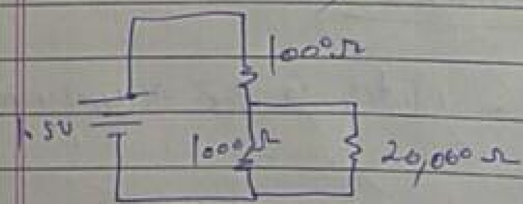
$I = \frac{1.5}{1500} = 1mA$

$V_{AB} = 1mA \times 500\Omega$

$= 0.5V$

Resistance of the meter

$= \frac{20,000\Omega \times 1V}{V} = 20,000\Omega$



$R_T = 1000 + \frac{1000 \times 20000}{21000}$

$= 1000 + 952.38$

$= 1952.38\Omega$

$I = \frac{1.5}{1952.38}$ $V_{AB} = I \times R_{AB}$

$= \frac{1.5}{1952.38} \times 1000\Omega \| 20000\Omega$

$\boxed{V_{AB} = 0.73V}$

Loading effect in multimeter

1. Sensitivity ↑, Loading effect ↓
2. Range (voltage range) R_T ↑, then also loa

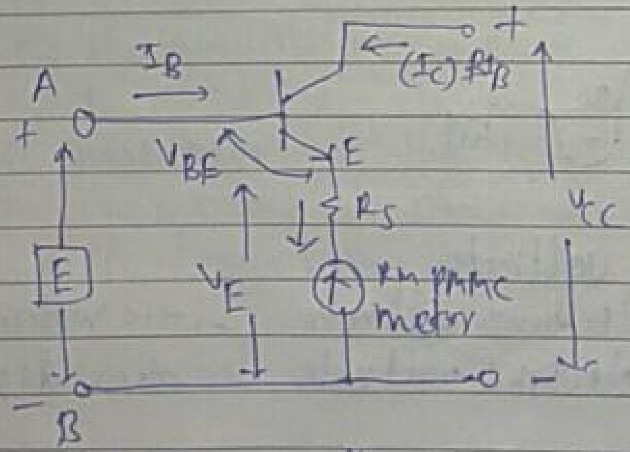
$\boxed{A}$ → 1000Ω/V → 0.5V

$\boxed{B}$ → 20000Ω/V → 0.75V

$\boxed{A}$ 1000Ω/V
1V $R_T = 1000\Omega$

$\boxed{B}$ 1000Ω/V
2V $R_T = 2000\Omega$
0.75V

Electronic voltmeter



Transistor voltmeter ckt

$I_C = \beta I_B$

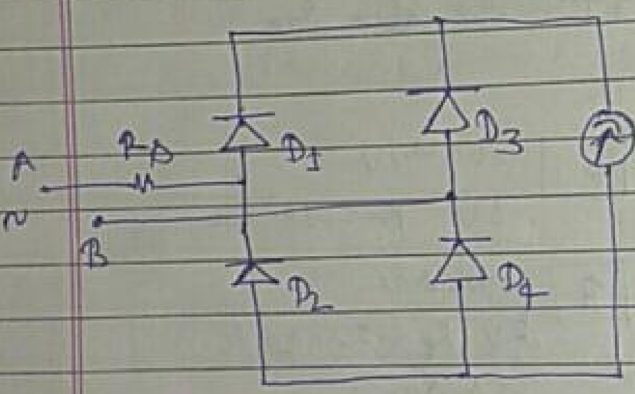
$V_E = E - V_{BE}$

$I_E = I_C = \beta I_B = I_m$

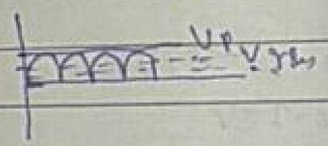
$$I_m = \frac{V_E}{R_S + R_m}$$

R_S = series resistance
R_m = meter resistance

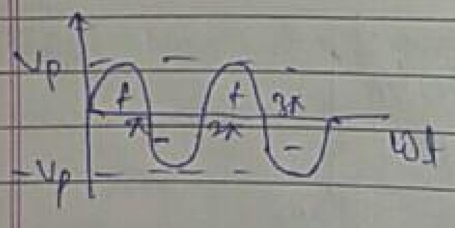
R_i = i/p Ω = $\frac{E}{I_B}$ dc voltage of the transistor voltmeter



$\boxed{\text{rms value} = 1.11 \times \text{av value}}$

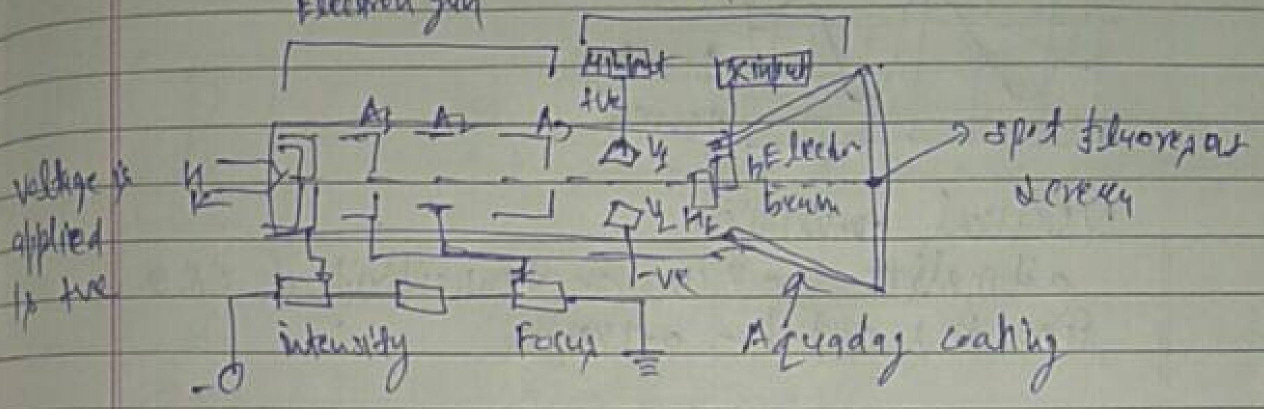


Bridge rectifier voltmeter



Electronic voltmeter
1. Rectifier electronic voltmeter → a.c voltage measurement
2. Transistor electronic voltmeter → d.c voltage measurement

Lecture 38



High voltage supply

H = Heater
K = Cathode
G = Control grid
A1 = Pre - accelerating anode
A2 = Focusing
A3 = Accelerating
Y_1Y_2 = vertical
H_1H_2 = Horizontal

Fig: CRT

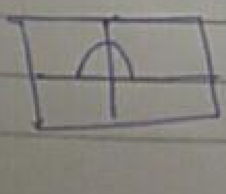
Deflection plates

1) Horizontal deflection plate
2) vertical deflection plate

Application of CRO

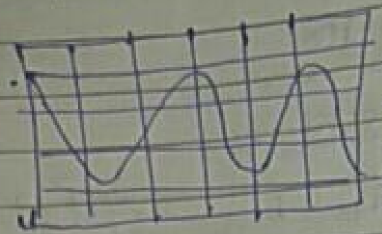
1. Analysis of waveform or study of waveforms
2. voltage measurment of the waveform
3. frequency mesurment of the waveform
4. Phase diff of waveform

i) Y - input terminal



i) Time base control
ii) Vertical amplifier

ii) Measurement of voltage



vertical amplifier
attenuator = 2 V/cm ← sensitivity of CRO
time base control = 0.1 ms/cm

$V_{pp} = 4\text{cm} \times 2\text{V/cm} = 8V$

$V_p = \frac{V_{pp}}{2} = 4V \quad V_{rms} = \frac{V_p}{\sqrt{2}} = \frac{4}{\sqrt{2}}$

Time period
$T = 4\text{cm} \times 0.1\text{ms/cm}$
$= 0.4\text{ms}$
frequency $= \frac{1}{0.4\text{ms}}$

Deflection sensitivity = 5V/cm

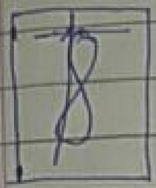
Y-input ← unknown ac voltage is applied
(vertical
deflection If 10 cm long straight line is observed
plate) on the screen.

ac voltage $V_{pp} = 10\text{cm} \times 5\text{V/cm}$
$= 50V$

$V_p = 25V \quad V_{rms} = \frac{V_p}{\sqrt{2}}$

unknown frequency

Lissanjour pattern



x-input ← signal of known frequency

y-input ← signal of unknown frequency

f_V = unknown

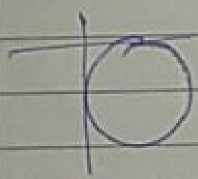
$f_H = 100KHz$

unknown frequency

$$\frac{f_V}{f_H} = \frac{\text{No. of horizontal tangencie's}}{\text{No. of vertical tangencie's}}$$

Known freq

$$\frac{f_V}{f_H} = \frac{1}{2} \Rightarrow f_V = \frac{f_H}{2} = 50KHz$$



Known freq $f_H = 50KHz$

$f_V = ?$

$$\frac{f_V}{f_H} = \frac{1}{1} \Rightarrow f_V = f_H = 50KHz$$