BITS, PILANI – DUBAI CAMPUS

II SEM 2012 – 2013

Course Code: INSTR C355 Date: 08.06.2013
Course Title: EIIT Max Marks: 50
Duration: 3 hours Weightage: 25%
Component: COMPREHENSIVE EXAMINATION (CLOSED BOOK)
Note: This question paper has 10 questions and 4 pages. Answer all questions

1(a) A 2mA meter movement with an internal resistance of 50Ω is to be used in a 0-10V, 0-50V, 0-100V and ~~0-250V~~ 0-1V ranges in the arrangement shown in Fig.1.find the value of required multiplier resistance.

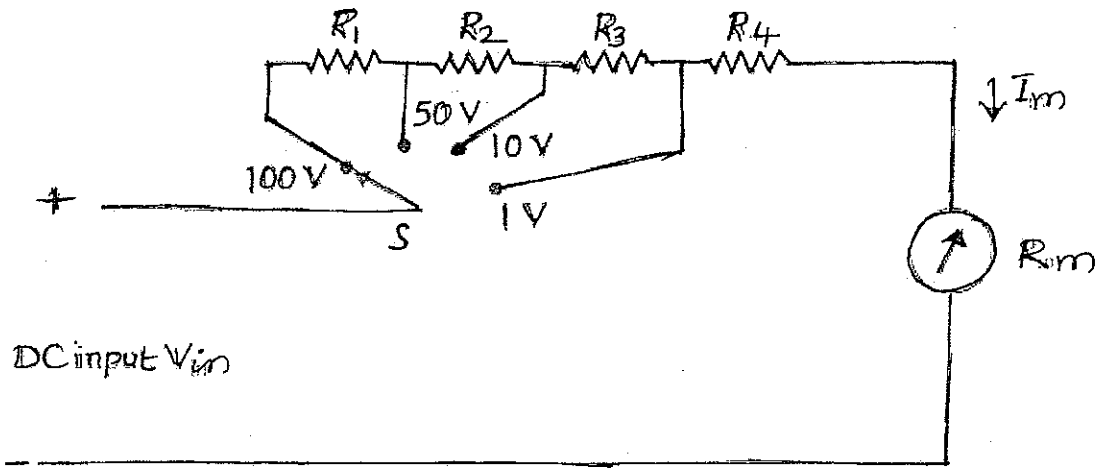

Fig.1

(b) Draw the circuit diagram of full wave bridge rectifier based meter and draw its input and output waveforms.

(c) Two different voltmeters are used to measure the voltage across R_b in the circuit of Fig.2.The meters are as follows;
Meter 1: S=1kΩ/V, R_m = 0.2kΩ, Range= 10V
Meter 2: S=20kΩ/V R_m=1.5kΩ, Range= 10V
Calculate (i) Voltage across R_b without any meter across it
(ii) Voltage across R_b when meter 1 is used
(iii) Voltage across R_b when meter 2 is used and
(iv) Error in the voltmeter 1

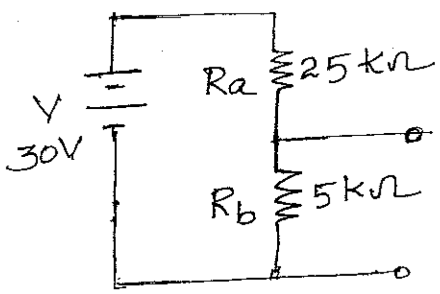

Fig. 2

[2M+1M+2M]

P.T.O

2(a) For a 3 1/2 digit DMM whose accuracy is given by
Accuracy = ±0.01% range ±0.1%reading
±2 digits
What would be displayed and what is the error for a 5V reading taken on the 20V range?.

(b) For a 4 bit R-2R digital to analog converter, R=10kΩ and V_{ref} =10V. Calculate value of R_f for (i) LSB corresponding to change of 0.4V (ii) desired analog output of 5V for a bit pattern of 1000 (iii) desired maximum output voltage of 14V.

(c) What is aliasing and show by figures the effect of sampling on a fast changing signal? Comment on the response. Write only key points in your answer..

[1M+2M+2M]

3(a) Two ac signals of same frequency but having a phase difference are displayed simultaneously on a dual trace CRO. If the horizontal separation between two neighboring peaks of the displayed waveform corresponds to 2 divisions and the distance between two consecutive peaks of a signal wave corresponds to 12 divisions of the horizontal scale, calculate the phase difference between the two signals

(b) What is delay line in a Cathode Ray Oscilloscope? Explain only key points in your answer.

(c) Draw the block diagram of X-Y recorder. [1M+2M+2M]

4(a) Name the bridge that is used for the measurement of permittivity of a dielectric. For Fig.3, without dielectric specimen between plates of Cs, balance is obtained with values C_1 =110pF,C_3=130pF,R_1=R_2=5kΩ.With the specimen inserted between plates of Cs, values for balance become C_1=200pF,C_3=900pF,R_1=R_2=5KΩ, ω=5000rad/sec.Find the relative permittivity of the specimen. Comment on the dissipation factor before and after the insertion of the specimen.

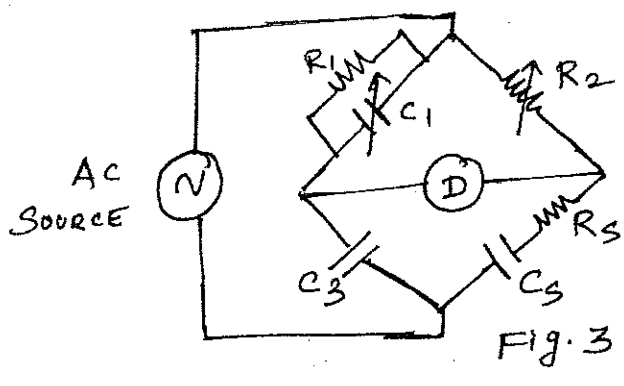

Fig. 3

(b) Design a wien bridge to be used in a wein bridge oscillator using op amp oscillating at a frequency of 10KHZ. Assume C=0.01μF.Draw the complete circuit diagram. [3M+2M]

5(a) Design the block diagram of an instrumentation system to analyze electroencephalogram (EEG). EEG can be classified into frequency bands Delta(0.5HZ to 2HZ),theta(2Hz to 6Hz),Alpha(6Hz to 12HZ),Beta(12Hz to 20Hz) and gamma (20Hz to 50Hz).The instrument should have a facility for display and recording of the signal

(b) Draw a suitable circuit for function generator using op amps which can generate, square waveform, triangular waveform and sine wave form. Draw the necessary waveforms at output of each op amp. [2M+3M]

6(a) Draw a typical character frame in a serial communication using RS232 and Explain. Write only key points in your answer.

(b) Explain HART field communication protocol. What are its benefits? Write only key Points in your answer [3M+2M]

7(a) Using indirect frequency synthesizer generate a frequency of 10MHZ with a frequency resolution of 100KHZ.

(b) What is the function of spectrum analyzer and how it is different from Oscilloscope? Write only key points in your answer.

(c) Explain the difference between distortion analyzer and a wave analyzer. Write only key points in your answer.

[2M+1M+2M]

8 (a) Explain how ratio of two frequencies can be measured? Give the block diagram.

(b) Let the input channel noise be 230μV and the input signal be 1mV rms noise over the band width of the front end of the computer. The counter is measuring a 1MHZ sine wave with a 1s gate time. The ± 1 count error is 0.001 HZ. The input rises to 330 mV in 1μs. Find the displayed frequency resolution.

(c) The distortion caused by the third harmonic is found to be 4.3% by using a wave analyzer. The total harmonic distortion when measured with a distortion analyzer is found to be 4.5%.If the rms value of the fundamental is 15V and if only the third and fifth harmonic are present, what is the rms value of the fifth harmonic?

[1M+2M+2M]

P.T.O

9. Explain the following with figures:
   (i) Transition (rise/fall) time
   (ii) Linearity
   (iii) Preshoot, overshoot and ringing [2M+1M+2M]

10(a) With the help of figures, show how the following waveforms are displayed in a CRO

   (i) A 2Vp-p sinusoidal waveform with 3V offset in DC mode
   (ii) A 2Vp-p sinusoidal waveform with 3V offset in AC mode

(b) Sketch the spectrum for the following signals:

   (i) Cos $2\pi ft$ with a frequency of 1KHZ
   (ii) Square wave of period=1msec and amplitude of 1V.
   (iii) $Cos^2(2\Pi ft)$ with a frequency of 1kHz [2M+3M]

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EIIT Answering scheme

Q1(a) 0 - 1V range

$$R_4 = \frac{V_m}{I_m} - R_m$$

$$= \frac{1}{2\times10^{-3}} - 50 = \underline{450\Omega} \rightarrow (\tfrac{1}{2}M)$$

0 - 10V range

$$R_3 = \frac{V_m}{I_m} - (R_m + R_4)$$

$$= \frac{10}{2\times10^{-3}} - (50+450)$$

$$= 5000 - 500 = 4.5k\Omega$$

$$= \underline{4500\Omega} \rightarrow (\tfrac{1}{2}M)$$

0 - 50V range

$$R_2 = \frac{V_m}{I_m} - (R_m + R_4 + R_3)$$

$$= \frac{50}{2\times10^{-3}} - (50 + 450\Omega + 4500\Omega)$$

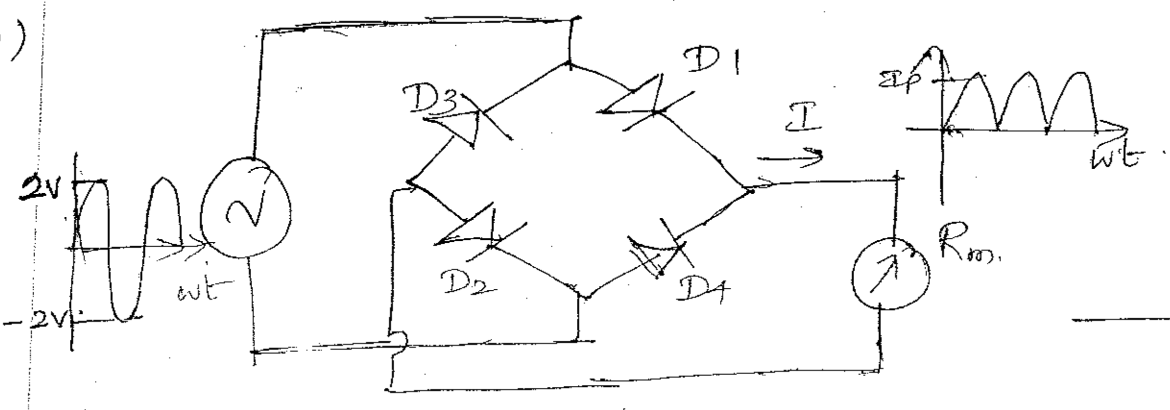
$$= 25000 - 5000 = \underline{20k\Omega} \rightarrow (\tfrac{1}{2}M)$$

0 - 100V - $R_1 = \frac{V_m}{I_m} - (R_m + R_4 + R_3 + R_2)$

$$= \frac{100}{2\times10^{-3}} - (50 + 450 + 4500 + 20)k\Omega$$

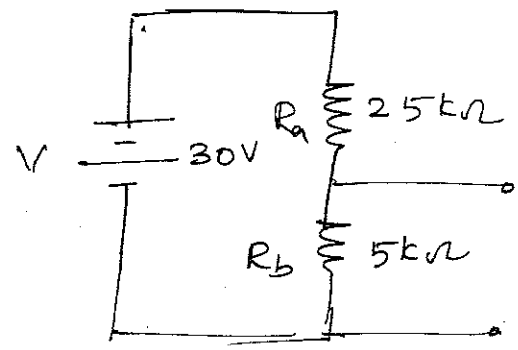
$$= \underline{25k\Omega} \rightarrow (\tfrac{1}{2}M)$$

(b)



→ (1M)

(c)



(i) step 1 :- Voltage across the resistance R_b without either meter connected

$$V_{Rb} = \frac{5k\Omega}{25k\Omega + 5k\Omega} \times 30V = 5V. \rightarrow (1/2 M)$$

(ii) step 2 :- Meter 1 with a sensitivity of 1kΩ/v

$$R_{m1} = S \times range = 1k\Omega/V \times 10V = 10k\Omega.$$

$$R_{eq} = \frac{R_b \times R_{m1}}{R_b + R_{m1}} = \frac{5k\Omega \times 10k\Omega}{5k\Omega + 10k\Omega} = 3.33k\Omega.$$

$$V_{Rb} = \frac{R_{eq}}{R_{eq} + R_a} = \frac{3.33k\Omega}{3.33 + 25k\Omega} \times 30 = 3.53V. \rightarrow (1/2 M)$$

(iii) step 3 :- Meter 2 with a sensitivity of 20kΩ/V & range of 10V.

$$R_{m2} = S \times range = 20k\Omega/V \times 10V = 200k\Omega.$$

$$R_{eq} = \frac{R_b \times R_{m2}}{R_b + R_{m2}} = \frac{5k\Omega \times 200k\Omega}{5k\Omega + 200k\Omega}$$

$$= \frac{1000k\Omega \times 1k\Omega}{205k\Omega} = 4.88k\Omega$$

$$V_{Rb} = \frac{4.88k\Omega}{4.88k\Omega + 25k\Omega} \times 30 = 4.9V \text{ --- } (1/2 M)$$

(iv) Error in reading of Volt-meter 1

$$\% \text{ Error} = \frac{\text{Actual voltage} - \text{Voltage reading observed in meter}}{\text{Actual voltage}} \times 100$$

$$= \frac{5V - 3.33V}{5V} \times 100$$

$$= \underline{33.4\%} \longrightarrow (1/2 M)$$

(2) (a) A 3½ digit DMM would display 00.00 to 19.99 on the 20V range → (½M)

1 digit represents in LSB (or) 0.01V.

$$\text{accuracy} = \pm\left(\frac{0.01}{100} \times 20 + \frac{0.1}{100} \times 5 + 0.02\right)$$

$$= \pm 0.027V.$$

Error is $\underline{5 \pm 0.03V}$. ⟶ (½ M)

2 (b)

$$\frac{N_R}{2^n} \frac{R_f}{R} = 0.4$$

$$\frac{10}{2^4} \times \frac{R_f}{10 \times 10^3} = 0.4$$

$$R_f = \frac{0.4 \times 10 \times 10^3 \times 2^4}{10} = \underline{6.4 k\Omega} \quad (1/2 M)$$

$$V_{out} = \frac{-R_f}{10k\Omega} \times 10 \left[\frac{0}{2^4} + \frac{0}{2^3} + \frac{0}{2^2} + \frac{1}{2^1} \right]$$

$$6 = \frac{-R_f}{10 \times 10^3} \times 10 \left[\frac{1}{2} \right]$$

$$R_f = 12k\Omega.$$ (½M)

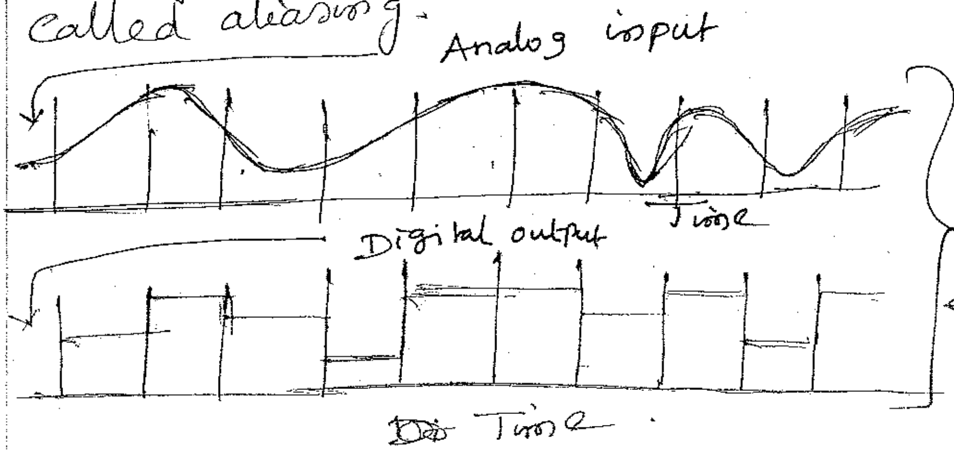
Maximum Voltage ⇒ 1111

$$14V = \frac{-R_f}{10 \times 10^3} \times 10 \left[\frac{1}{2^4} + \frac{1}{2^3} + \frac{1}{2^2} + \frac{1}{2^1} \right]$$

$$R_f (0.0625 + 0.125 + 0.25 + 0.5) = 14V$$

$$R_f = 14.93k\Omega.$$ (1M)

(2)(b). If the A/D Converter is subjected to an analog input signal whose frequency exceeds the Nyquist frequency for the A/D Converter, the Converter will output a digitized signal of falsely low frequency. This phenomenon is called aliasing. (1M)



(½M) (1M) fast changing signals are missed out.

(3)(a)

phase difference $\Rightarrow \frac{2\pi}{D} \times d$.

$\Rightarrow \frac{2\pi}{12} \times 2$

$\Rightarrow \frac{\pi}{3}$ radians.

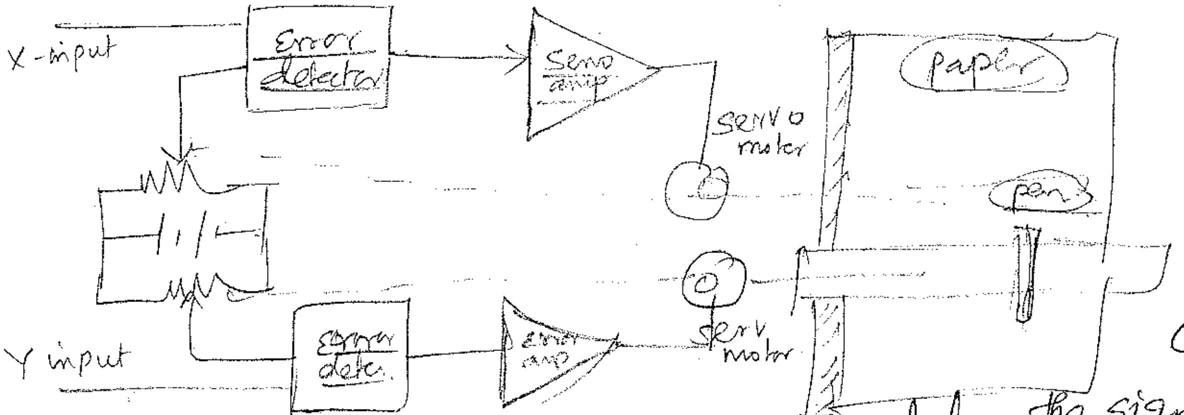
$= 60°$ degrees.

(1M)

14 div ⇒ 360°
2 div ⇒ ?

$\frac{2 \times 360}{14}$.

3(C)



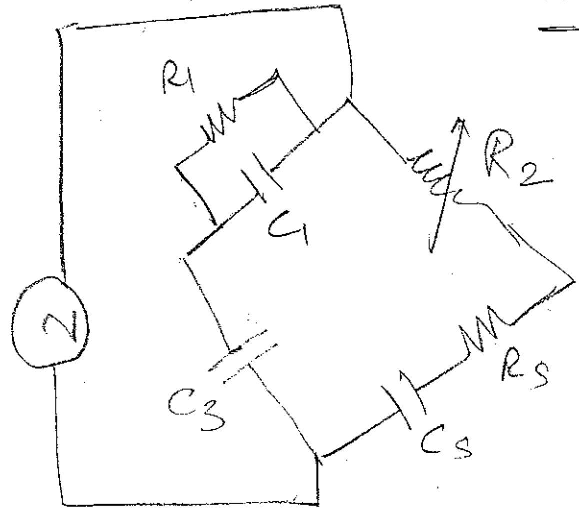
(2M)

(b) A delay line is used to delay the signal in the vertical section. The signal in the horizontal has to pass through the trigger pick off circuit. The time base generator and horizontal amplifier before it finally reaches the horizontal deflection plates. The signal therefore takes longer to reach the HDP as compared to vertical section. This gives an error in which the initial portion of the input signal is lost. The distortion can be overcome by using a delay line in the vertical section.

(2M)

(4)(a)

Schering bridge



$C_1 = 110\,pF$

$C_3 = 130\,pF$

$R_1 = R_2 = 5\,k\Omega$

$$R_S = \frac{C_1 R_2}{C_3}$$

$$C_S = \frac{C_3 R_1}{R_2}$$

$$R_S \Rightarrow \frac{110\times10^{-12} \times 5\times10^{3}}{130\times10^{-12}}$$

$$\Rightarrow 4.231\,k\Omega$$

$$C_S = \frac{130\times10^{-12}\times 5\times10^{3}}{5\times10^{3}} = 130\,pF$$

with the Sample inserted the new values are.

$$C_1 = \frac{900\times10^{-12}\times 5\,k\Omega}{5\,k\Omega} = 900\,pF$$

~~$R_S = \frac{900\times10^{-12}\times5\times10^{3}}{130\times10^{-12}}$~~

$$\varepsilon_r = \frac{900}{130} = 6.92 \quad \text{(1M)}$$

Dissipation factor before insertion of sample

$$D_1 = \omega R_S C_S$$

$$= 5000\times 4.231\times10^{3}\times 130\,pF$$

$$= 2.750\times10^{-3} \quad \text{(1M)}$$

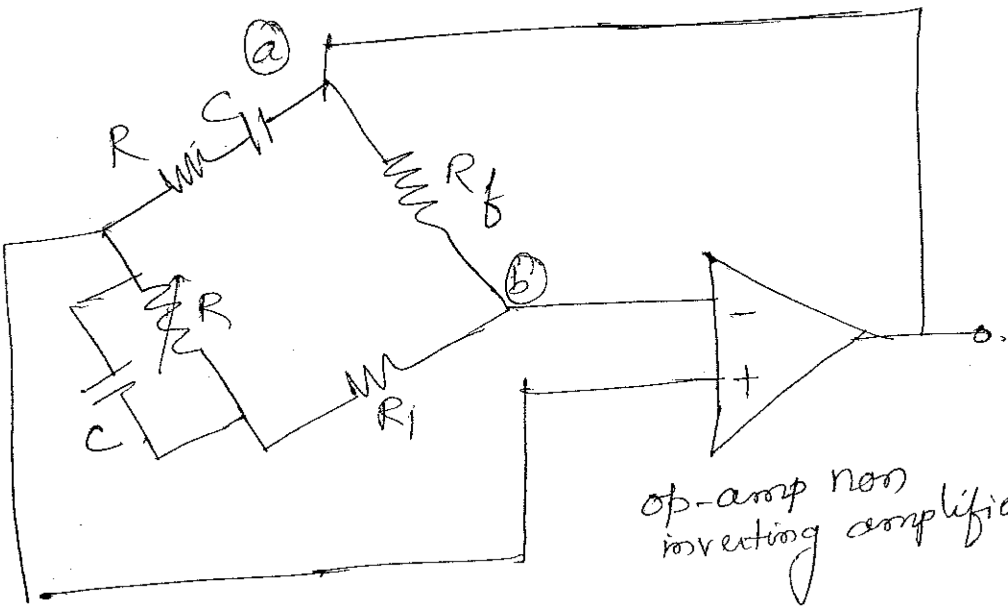
After insertion of the Sample

$$D = 5000\times4.031\times10^{3}\times 900\,pF$$

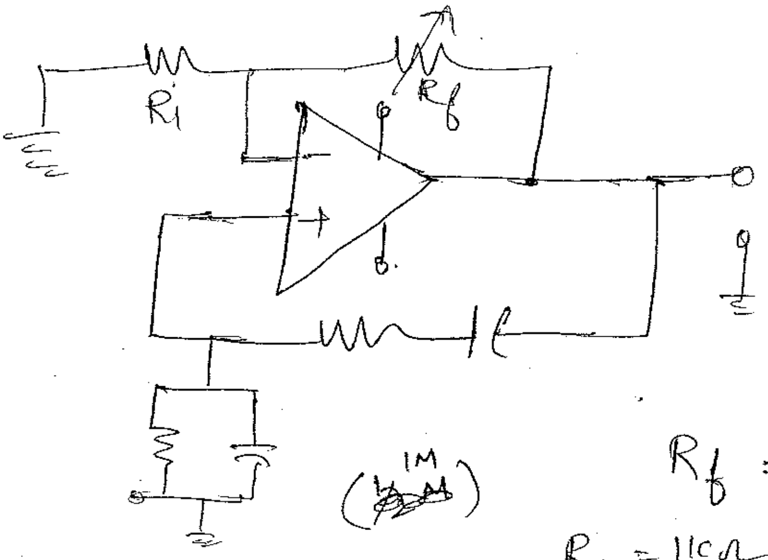
$$\Rightarrow 18.13\times10^{-3} \quad \text{Dissipation} \uparrow \quad (1/2\,M)$$

(1/2)

(4)(b).



The Circuit Can be redrawn as.



(1M)

$C = 0.01 \mu F$.

$R = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi \times 10 \times 10^3}$

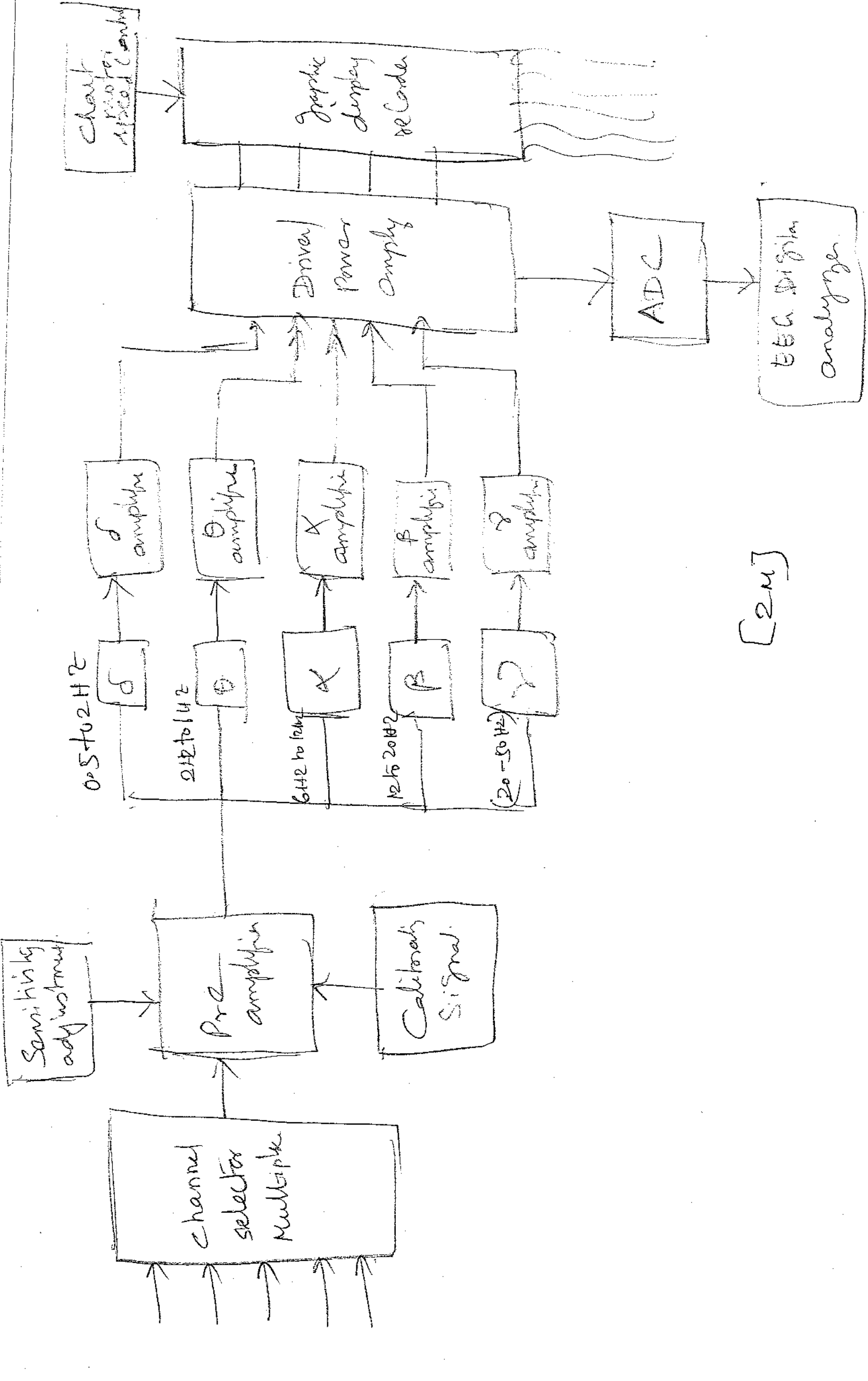
$= 1.592 k\Omega$. (1/2 M)

$R_f = 2R_1$.

$R_1 = 1k\Omega$ $R_f = 2k\Omega$.

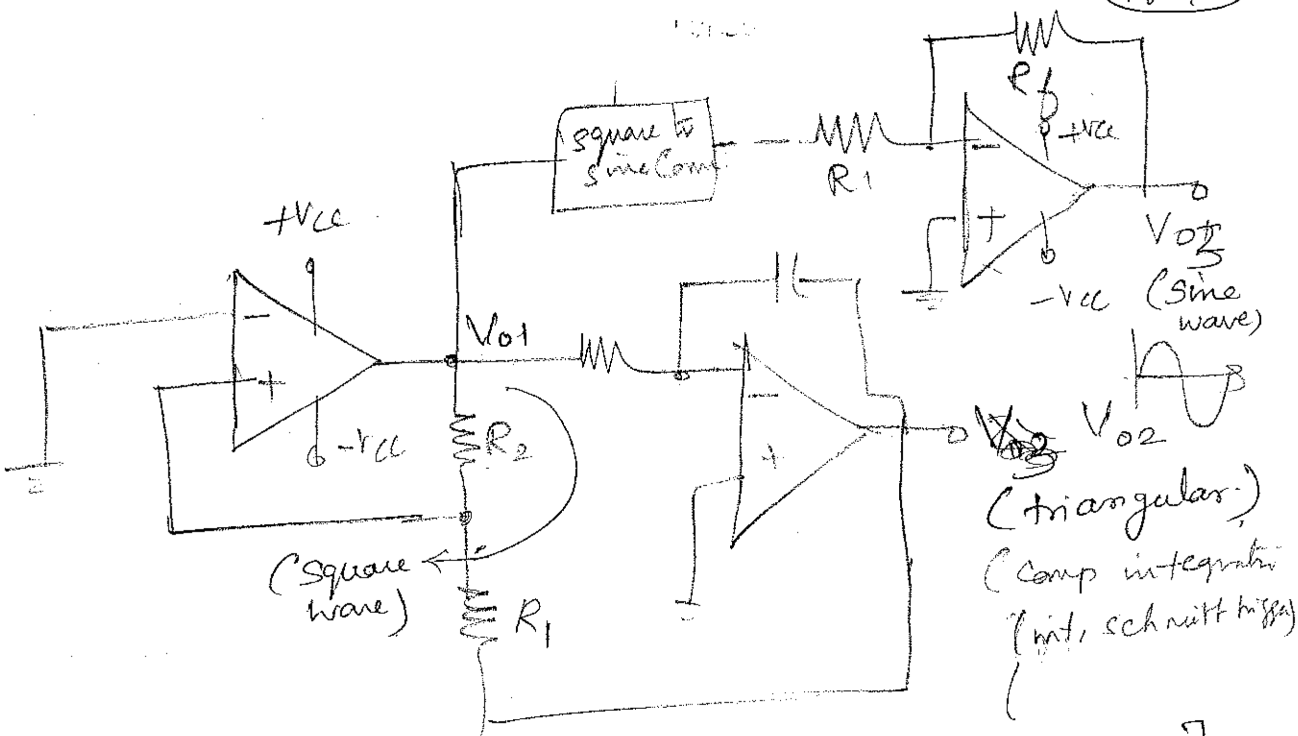
$A_{CL} > 3$. (1/2 M)

5(a)


Graphic display recorder
Driver Power amplifier
ADC
EEG Digital analyzer
δ amplifier
θ amplifier
α amplifier
β amplifier
γ amplifier
δ
θ
α
β
γ
0.5 to 2 Hz
(20-50 Hz)
Pre amplifier
Calibration signal
Channel selector Multiplexer

[2M]

(b)



[2M]

$V_{01} \Rightarrow$ Square wave.

$V_{02} \Rightarrow$ triangular wave.

$V_{03} \Rightarrow$ Sine wave.

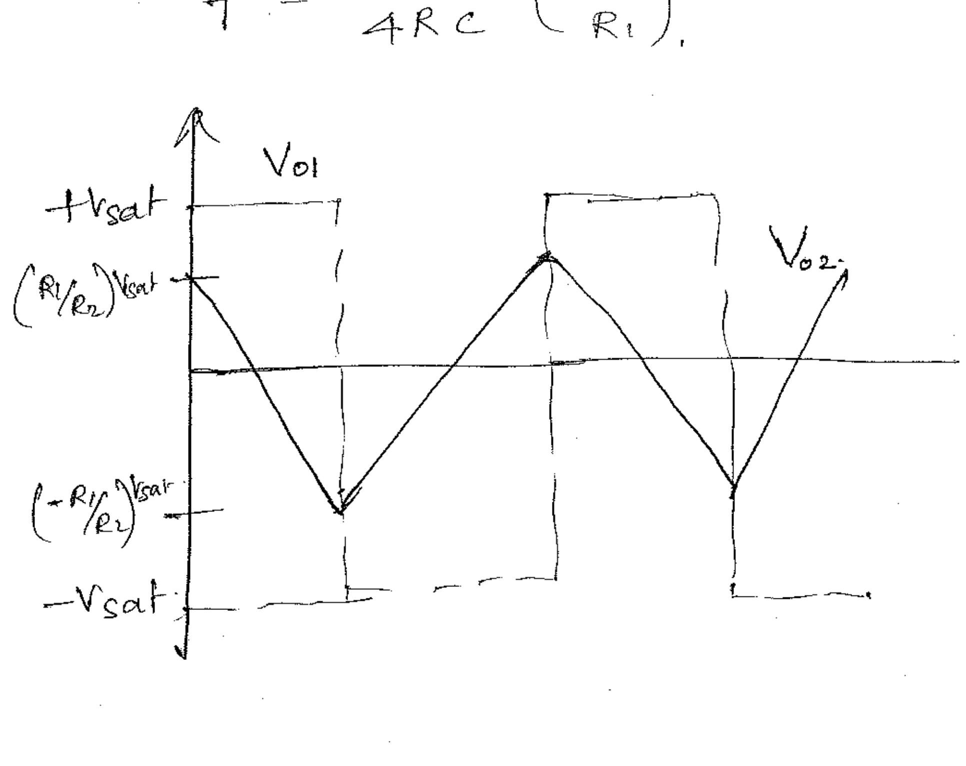
Assume $R_1 = R_2 = 1k\Omega$

Vcc ⇒.

(or) triangular to sine wave Converter.

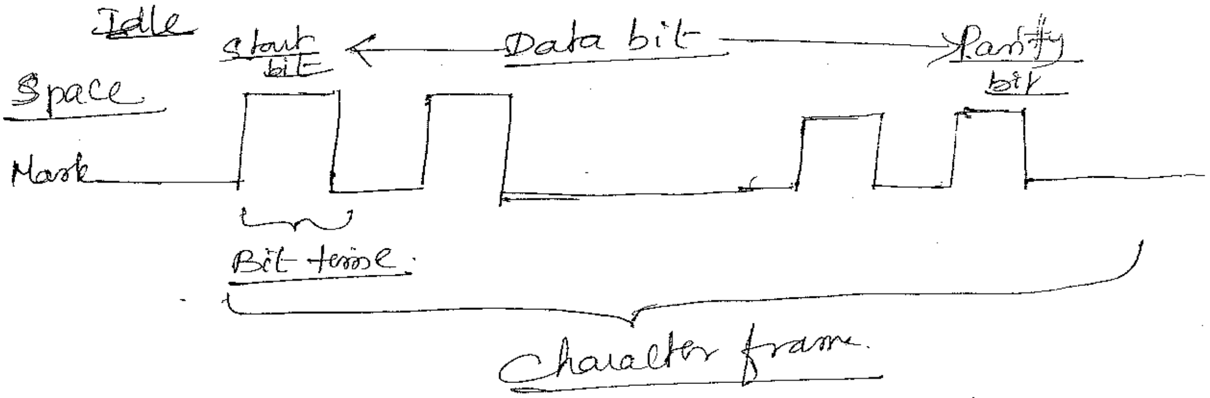
$$V_{02} = \frac{R_1}{R_2} \times V_{cc} \Rightarrow$$

$$f = \frac{1}{4RC}\left(\frac{R_2}{R_1}\right).$$



[1M]

(6)(a). Each transmitted character is Packaged in a character frame that consists of a single start bit followed by data bit. the optional parity bit and the stop bit or bits



RS232 → uses two Voltage states like MARK & SPACE (+3V for space) (Logic 0)
(-3V Logic 1)

Vout ⇒ Swings between +12V & -12V.

Start bit → transition from negative (MARK) to Positive (SPACE). 1/Baud rate

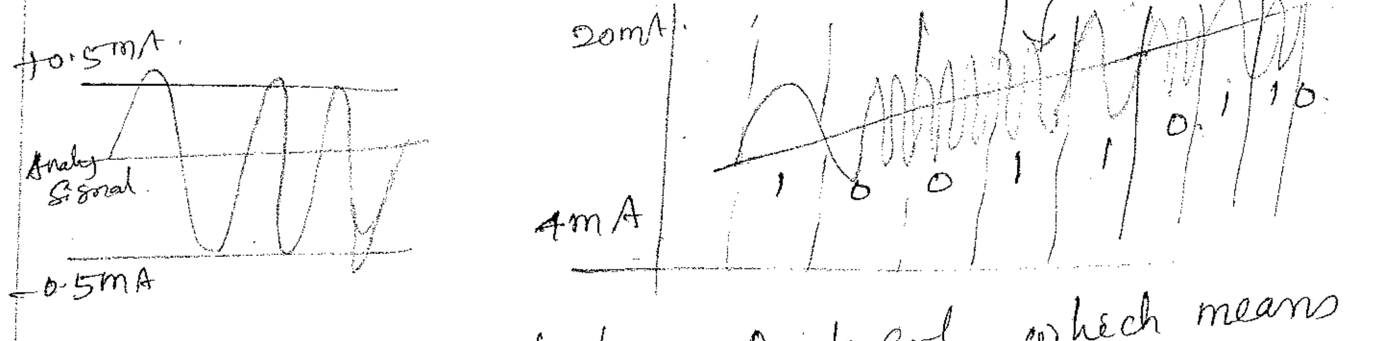
Data bit :→ transmitted "upside down & backwards" inverted logic is used & order of transmission from LSB to MSB.

Parity bit → An optional parity bit follows the data bits in the character frame. It is included as a simple means of error checking & is set depending upon whether the parity bit of the transmission is even or odd.

Stop bit → End of Character frame & has a marking value.

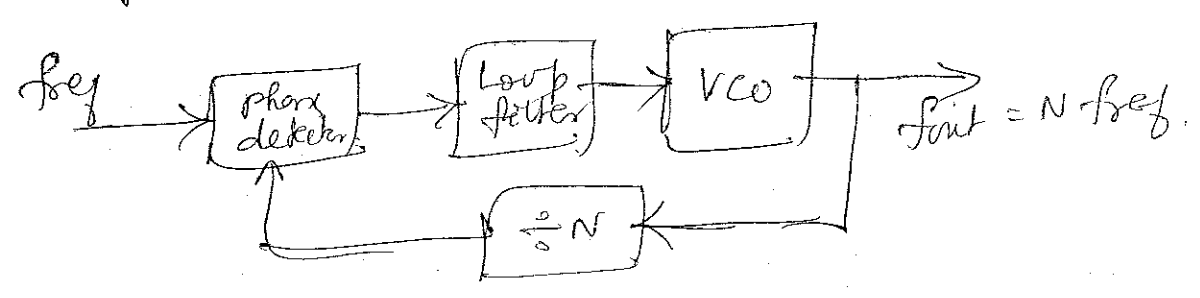
[3M]

6(b) **HART** → Highway addressable remote transducer. makes use of FSK to superimpose digital communication signals at a low level on the top of 4-20mA. This enables two way field communication to take place & makes it possible for additional information. The protocol communicates at 1200bpF without interrupting 4-20mA signal and allows a host application to get two or more digital updates per second from a field device. As the digital FSK signal is phase continuous there is no interference with 4-20mA signal.



HART → master/slave Protocol which means that a field (slave) device only speaks when spoken to by a master. [2M]

7(a). Indirect frequency synthesizer employ a secondary oscillator controlled by a phase locked loop (PLL) or a frequency locked loop to generate the output frequency



The basic form of PLL Consists of a VCO a freq divider, phase detector and a loop filter. The VCO generates the synthesized freq according to a dc level at its input. Such an arrangement allows the possibility of solving a synthesizer frequency to a spacially base lower reference frequency. In the lock Condition, the Vco output frequency is related to the reference frequency fout is related to the reference frequency by the fout = N fref where N is divider modulus.

$f_{out} = 10MHZ$.

$f_{ref} = 100 KHZ$.

$\therefore N = \frac{f_{out}}{f_{ref}} = \frac{10 \times 10^6}{100 \times 10^3} = 100$ [2M]

$N = 100$.

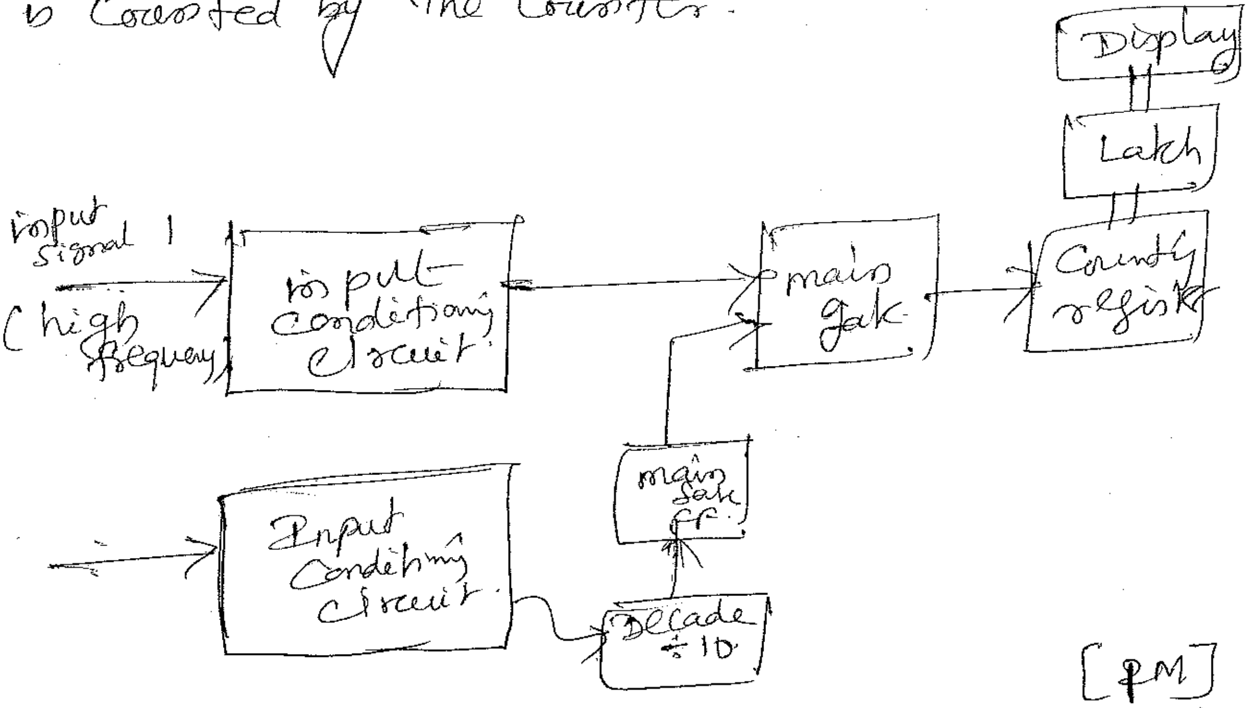
7(b) Function of Spectrum analyzer — to Provide freq domain view.

oscilloscope → used to display the measure signal in time domain whereas Spectral analyzer is used to display signal in the freq domain [1M]

(c) Distortion analyzer →. Can measure the total harmonic distortion.

wave analyzer → can measure each harmonic individually. [2M]

8(a) The ratio of two frequencies is determined by using the lower frequency signal for gate control while the higher frequency signal is counted by the counter.



[8M]

(b) L.S.D = 0.001 HZ.

$$\text{Trigger error} = \frac{\sqrt{(230)^2 + (1000)^2}\ \mu V}{330\ mV/1\mu s}$$

$$\Rightarrow \frac{\sqrt{(230\times10^{-6})^2 + (1\times10^{-3})^2}}{330\times10^{-3}/1\times10^{-6}}$$

$$\Rightarrow \frac{\sqrt{(230)^2 + (1000)^2}\ \mu V}{330\ mV/1\mu s}$$

$$\Rightarrow \frac{1026.109\times10^{-3}}{330,000}$$

$$\Rightarrow 3.08\times10^{-9}$$

Frequency resolution $= \pm 1 \text{ LSD} \pm \sqrt{2} \times \frac{\text{trigger error}}{\text{gate time}} \times \text{freq}$

$= \pm 0.001 \pm 1.4 \times 3.109 \times 10^{-9} \times 1 \text{ MHZ}$

$= \pm 0.005 \text{ HZ}$ [2M]

(c)

$T.H.D = 4.5\%$

$HD_3 = 4.33\%$

$THD = \frac{\sqrt{(E_3^2 + E_5^2)}}{E_f} = 4.5\% = 0.045$

$E_3^2 + E_5^2 = (0.045 \times 15V)^2$

$E_3^2 + E_5^2 = 0.675 V^2 \longrightarrow (1)$

$HD_3 = \frac{\sqrt{E_3^2}}{E_f} = 0.0433$

$E_3^2 = (0.0433 \times 15V)^2$

$\Rightarrow 0.433 V^2 \longrightarrow (2)$

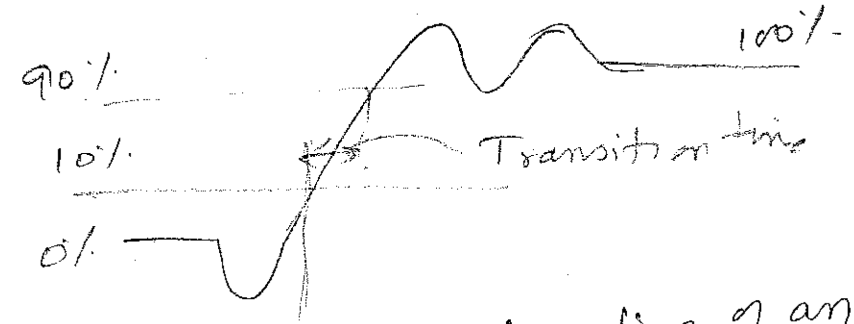
$E_5^2 \Rightarrow 0.675 V^2 - 0.433 V^2$

$E_5^2 \Rightarrow 0.242 V$

$\boxed{E_5 = 0.492}$ [2M]

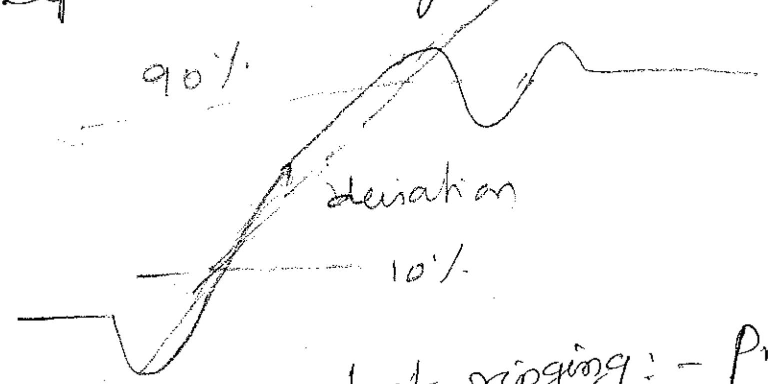
(9)

Transition (rise/fall) time :- interval between 10% & 90% amplitude.



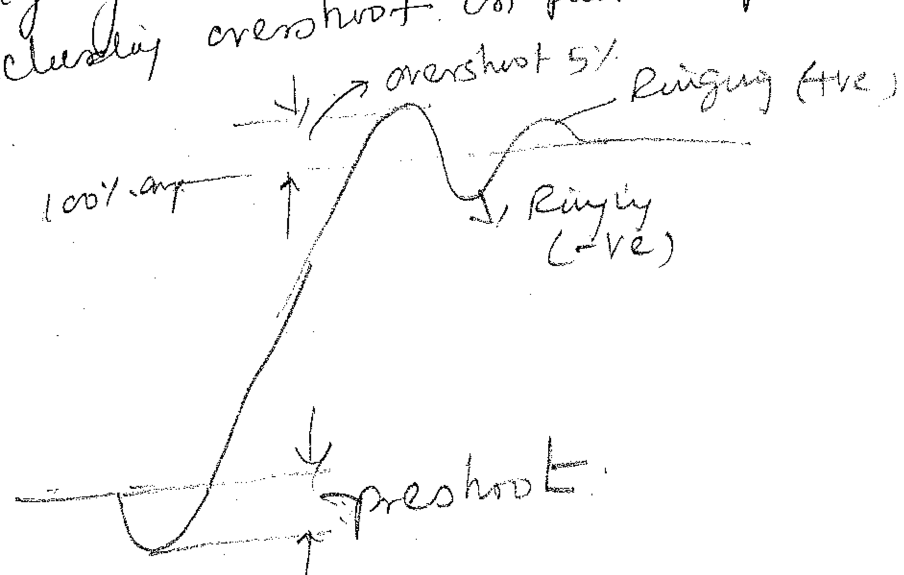
[2M]

Linearity :- Peak deviation of an edge from a straight line through 10% & 90% amplitude points expressed as %age of pulse amplitude.

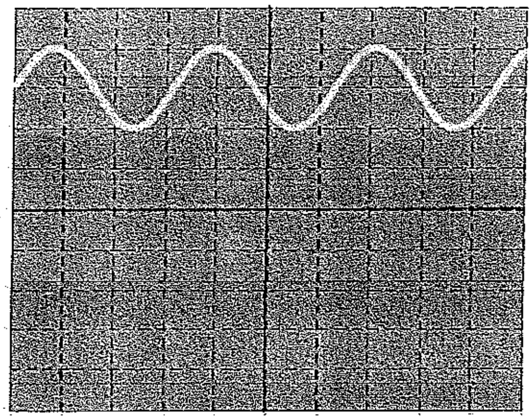


[1M]

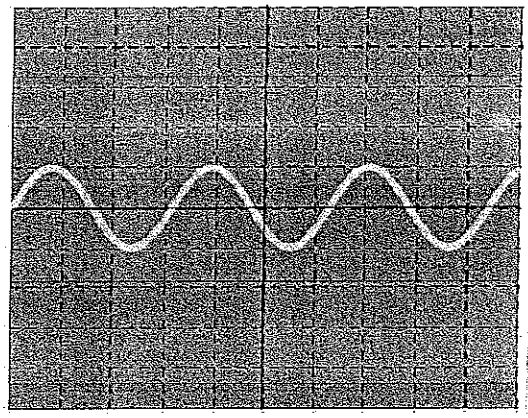
Preshoot overshoot ringing :- Preshoot & overshoot are peak distortions preceding/following an edge. Ringing is +ve peak & negative peak distortion excluding overshoot on pulse top or base.



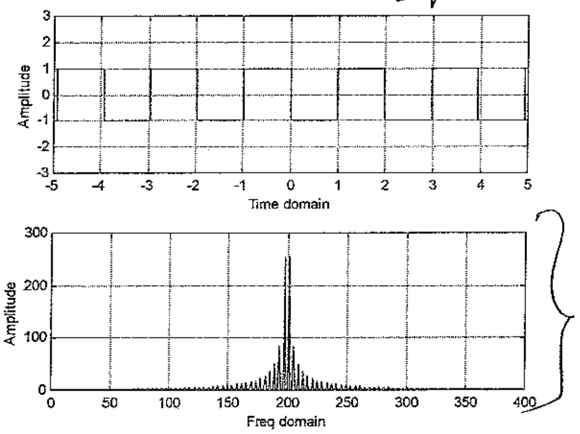
(2M)



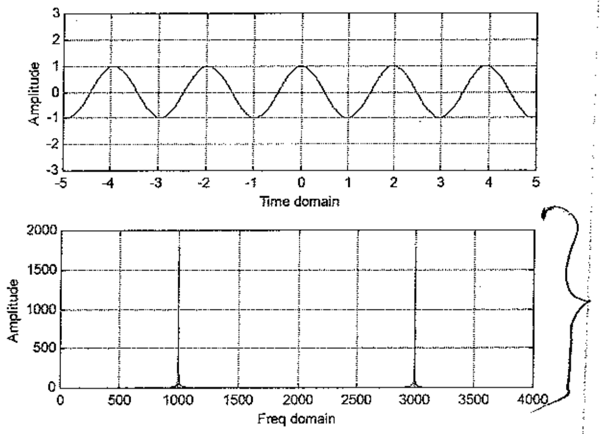
~~Cos2πft~~ Square [1M]



~~Square wave~~ cos2πft [1M]

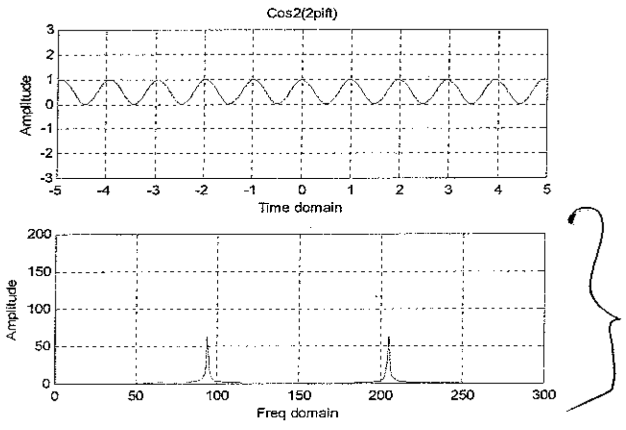


[1M]



[1M]

$Cos^2(2\pi ft)$



[1M]

(b) (91)

II SEM 2012-2013
BITS PILANI, DUBAI CAMPUS
III YEAR EIE

Course Code: INSTR C55
Course Title: EIIT
Duration: 50 Minutes
Component: TEST 2 (Open Book)

Date: 2.05.2013
Max Marks: 15
Weightage: 15%

Note: This question paper has 5 questions. Answer all Questions. Assume suitable data if required.

1 With the help of whetstone's DC bridge and op amp based circuits, design a signal conditioning circuit for the following specifications:

(i) Connect RTD of platinum type in one arm of the DC bridge circuit which has the temperature variations of 30°C-90°C

(ii) Design a suitable circuit using whetstones bridge and op amps which can give 4-20mA output for a temperature range of 30°C-90°C .Use $\alpha = 0.0034/°C$. P_D =30mW/$°C$. The error due to self-heating of the RTD should not exceed 1°C.

[5 Marks]

2. Design a frequency synthesizer which can synthesize frequencies 1.1,2.1, 3.1,....9.1MHZ. You can combine more than one technique to obtain the mentioned frequencies. [3 Marks]

3. Use a multiple loop indirect synthesizer to synthesize a frequency of 15.5MHZ from a 10MHZ reference source [2 marks]

4. Determine the total harmonic distortion for a power amplifier .The total collector current for a power amplifier is given by

$$I_c = (2.5)(2+v_{in})^3 \text{ mA}$$

Where the input v_{in}(in mV) =10sinωt.

[2Marks]

Test 2 (open Book)

(1) $R_t = R_0 [1+\alpha(\Delta T)]$

$R_{30^\circ c} = R_0 [1+\alpha(\Delta T)]$

$= 100 [1+0.0034(30)]$

$= 110.2\Omega$

$R_{90} = 100 [1+0.0034(90)]$

$= 130.6\Omega.$

$P_D = 30 mW/^\circ C.$ $\Delta T = P/P_D$

P = Power dissipated in RTD in watts.

P_D = Dissipation Constant of RTD in $W/^\circ C$.

~~$V_{R40} \Rightarrow$~~ $30mW = I^2 \times 110.2.$

$I^2 = \frac{30 \times 10^{-3}}{110.2} = 16.49 mA.$

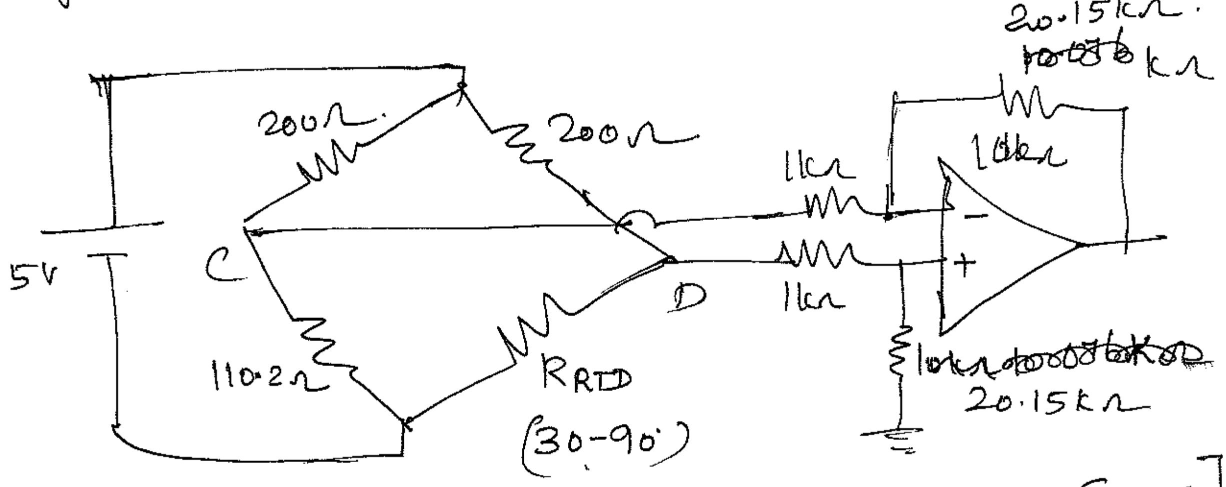
$V_{R40} = 16.49 \times 10^{-3} \times 110.2 = 1.818V.$

$\frac{(5 - V_{R40})}{I_{R40}} = R_3 = 192.95\Omega. \doteq 200\Omega$

Bridge output at null condition i.e at 30°c.

$R_3 = R_2 = 200\Omega$ $R_1 = R_{40} = 110.2\Omega.$

Bridge output at 30°C.



[3.5]

$$(\Delta V)_{30^\circ C} \Rightarrow \left[\frac{110.2\Omega}{110.2 + 200} - \frac{110.2}{110.2 + 200} \right]$$

$$\Rightarrow 0V.$$

$$(\Delta V)_{90^\circ C} \Rightarrow \left[\frac{130.6\Omega}{130.6 + 200} - \frac{110.2\Omega}{110.2\Omega + 200} \right]$$

$$\Rightarrow \left[0.3950 - 0.3553 \right]$$

$$= 0.0397V \times 5V \Rightarrow 0.1985V.$$

output of Diff amplifier $\Rightarrow \frac{R_f}{R_1}\left[V_D - V_C\right]$

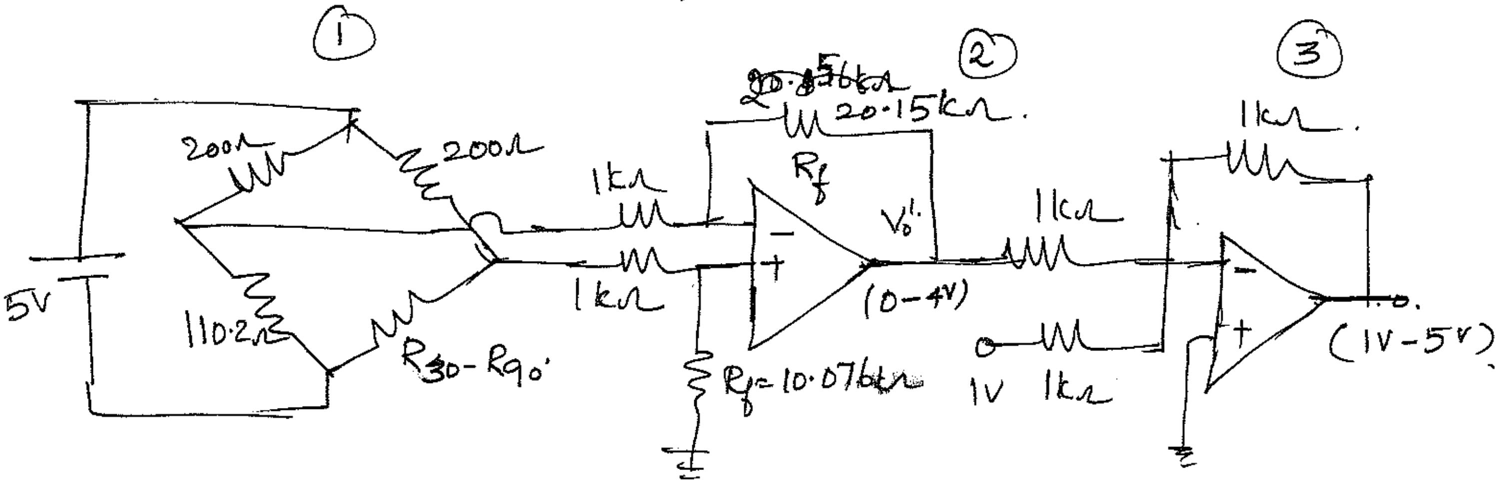
$$\Rightarrow \frac{10k\Omega}{1k\Omega}\left[0.3950 - 0.3553\right]$$

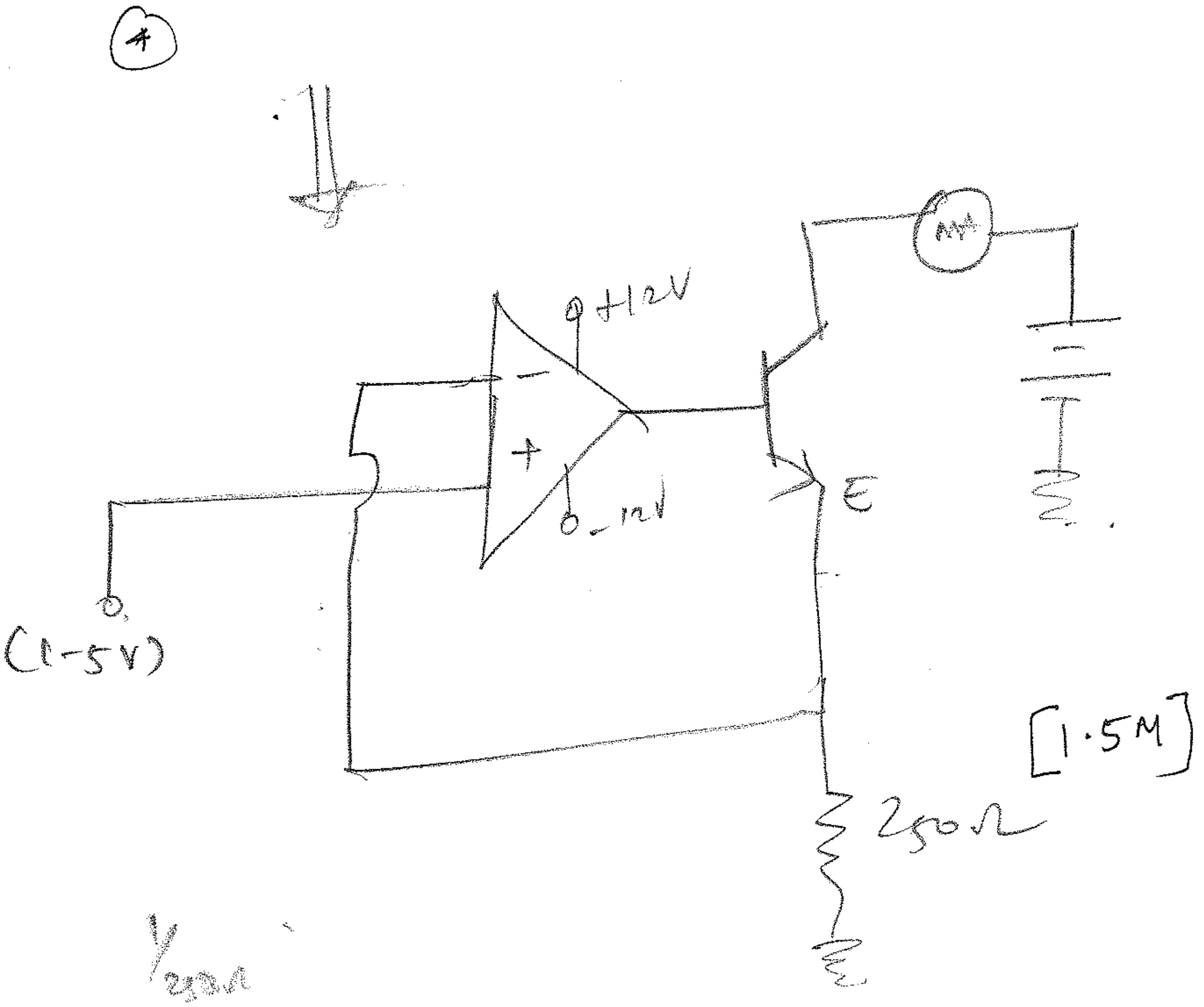
$$\Rightarrow \frac{0-2V.}{V_{90}} \Rightarrow \frac{2V}{0.1985} \Rightarrow$$ ~~5.063V.~~ ~~0.3950~~ $\Rightarrow$ ~~20.076~~ 20.152

~~R~~ RTD at 30°C ⇒ 0V.

RTD at 90°C ⇒ 0.1985 × ~~...~~ 20.15

⇒ ~~...~~ 4V.

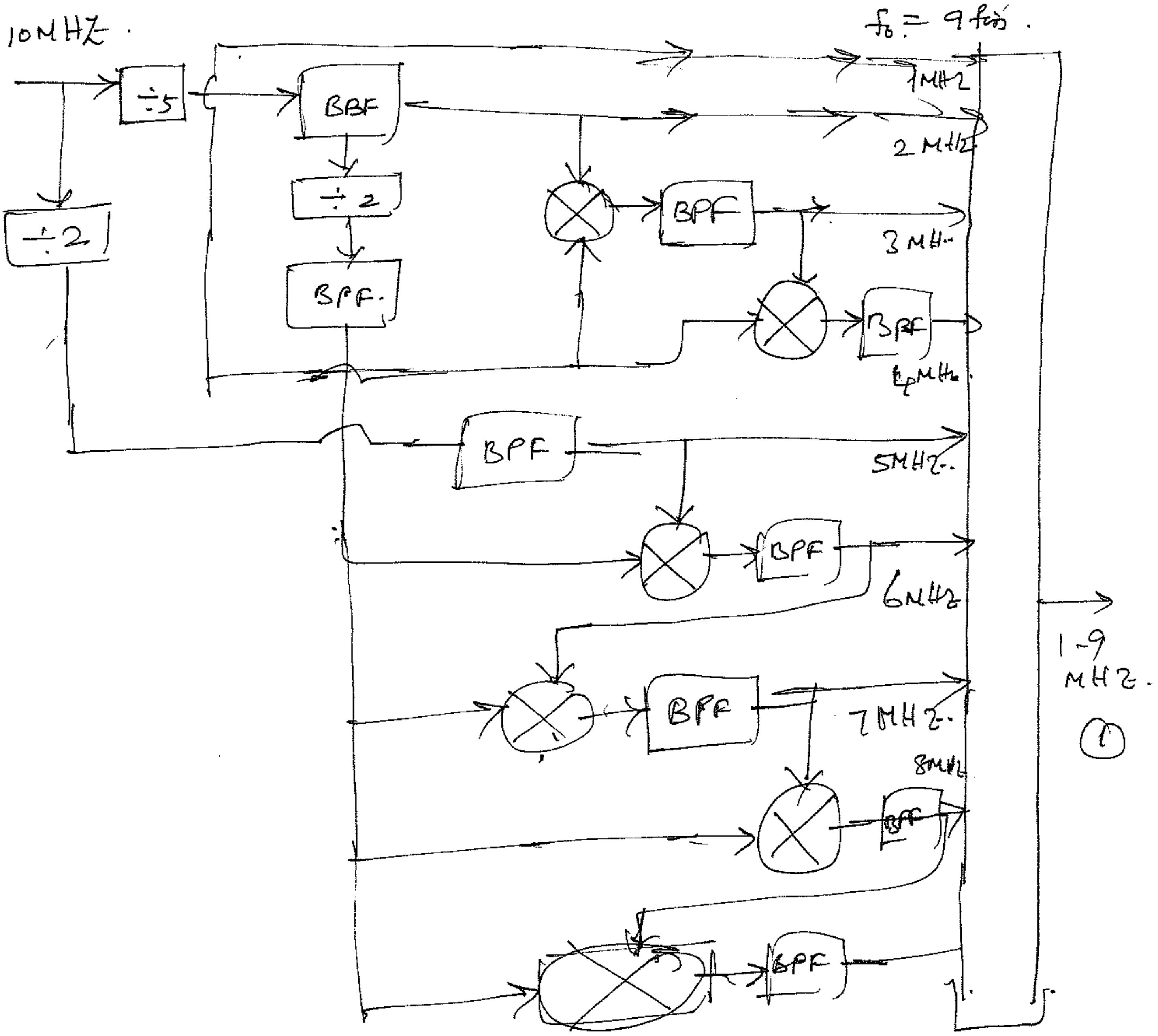


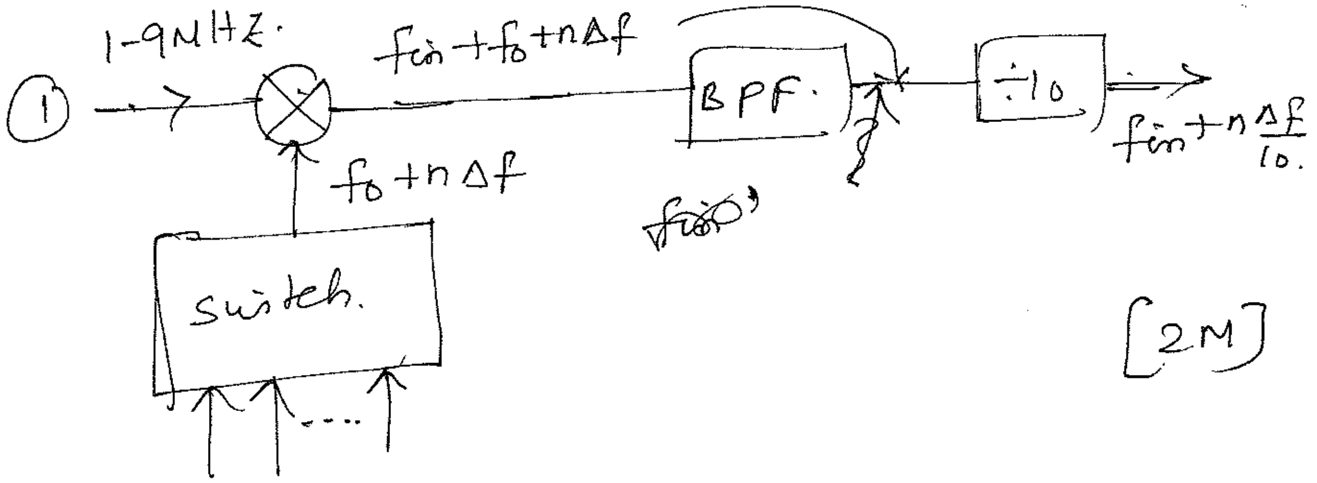


(2)

$f_o = 10f_{in} - f_{in}$

$f_o = 9f_{in}$.





[2M]

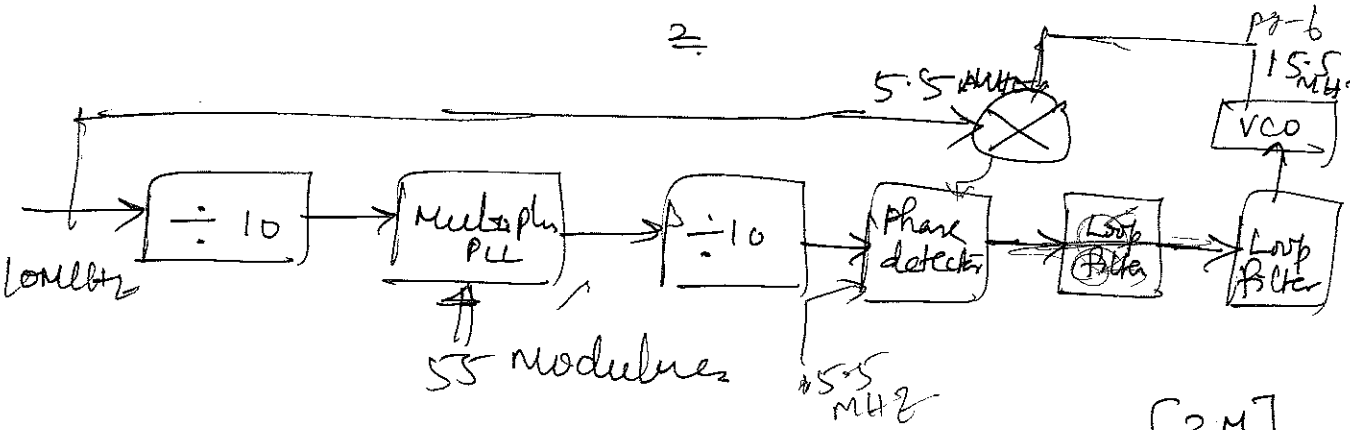
The frequencies to be generated are 1.1 2.1 ..... 9.1 MHZ.
To obtain those frequencies direct analog synthesis and fast switching synthesizer are to be used. The direct analog synthesizer synthesizes frequencies in the range 1-9 MHZ. and fast switching synthesizer to generate the decimal frequencies.

Choose $n=1$ $\Delta f = 1\,MHZ$. ⟶ [1M]

$f_0 = 1.1 \quad 2.1 \quad 3.1 \quad \ldots \quad 9.1\,MHZ$.

2

(3)



[2M]

(4) $i_C = (2.5)(2+V_{in})^3 \, mA.$

$= 2.5\left[8 + 12V_{in} + 6V_{in}^2 + V_{in}^3\right]$

$= 20 + 30V_{in} + 15V_{in}^2 + 2.5V_{in}^3$.

$V_{in} = 10 \sin \omega t$.

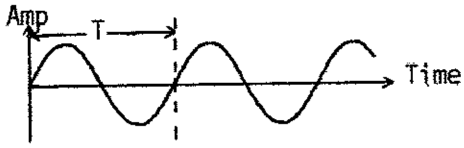
$= 20 + 300 \sin \omega t + 750 - 750 \cos 2\omega t + 1875 \sin \omega t - 625 \sin 3\omega t$.

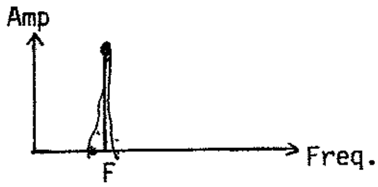
$= 770 + 2175 \sin \omega t - 750 \cos 2\omega t - 625 \sin 3\omega t$.

$T.H.D = \dfrac{\sqrt{(750)^2 + (625)^2}}{2175}$

$= 0.4485 = \underline{44.85\%}$. → [2M]

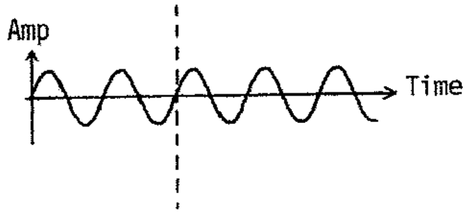
Waveform A
Frequency = F
Period = T

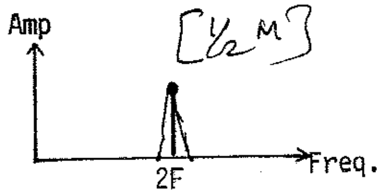




[1/2 M]

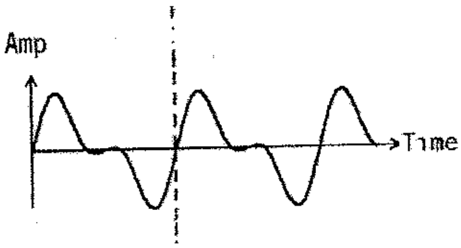
Waveform B
Frequency = 2F
Period = T/2



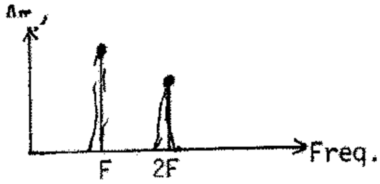


[1/2 M]

Waveform A+B
Period = T



[1M]



[1M]

BITS, PILANI – DUBAI CAMPUS

II SEM 2012 – 2013

Course Code: INSTR C355 **Date: 14.03.2013**
Course Title: EIIT **Max Marks: 15**
Duration: 50 Minutes **Weightage: 15%**
Component: TEST 1 (Closed Book)
Note: This question paper has six questions. Answer all the questions

1. A control valve has a linear variation of opening as the input voltage varies from 0-10V.A microcontroller outputs an 8 bit word to control the valve opening using an 8 bit DAC to generate voltage.
   (i) Find the reference voltage required to obtain a fully open valve(10V)
   (ii) Find the percentage valve opening for 1 bit change in input word.
   (iii) What bit DAC is required if the control Valve has at least 0.1% change of valve opening. [3M]
2. Figure 1 shows a simple circuit of R_1 and R_2connected to a 100V dc source. If the voltage across R_2 is to be measured by voltmeters having
   (i) a sensitivity of 1000Ω/V and
   (ii) a sensitivity of 20,000Ω/V

   Find which voltmeterwill read the accurate value of voltage across R_2.Both the meters are used on the 50 V range. Comment on your answer. [3M]

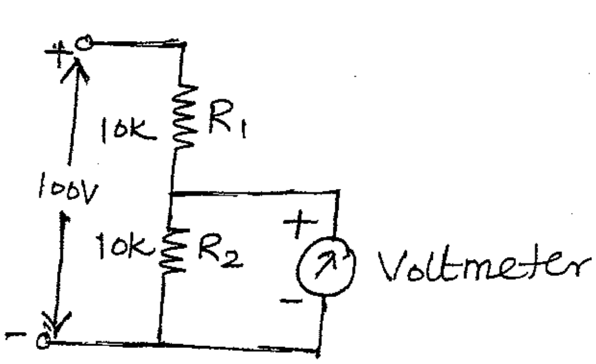


Figure 1

3. Briefly explain typical scales used in series type and shunt type ohmmeter with diagram [2M]

P.T.O

4. When Time-base is switched off and the oscilloscope is switched to XY mode of operation. V_1 is connected to the x-input with sensitivity of 0.1V/cm and V_2 is connected to the Y input with sensitivity 0.2V/cm. The resulting ellipse is shown in Figure 2. Calculate the necessary distances and find the phase shift between V_1 and V_2.

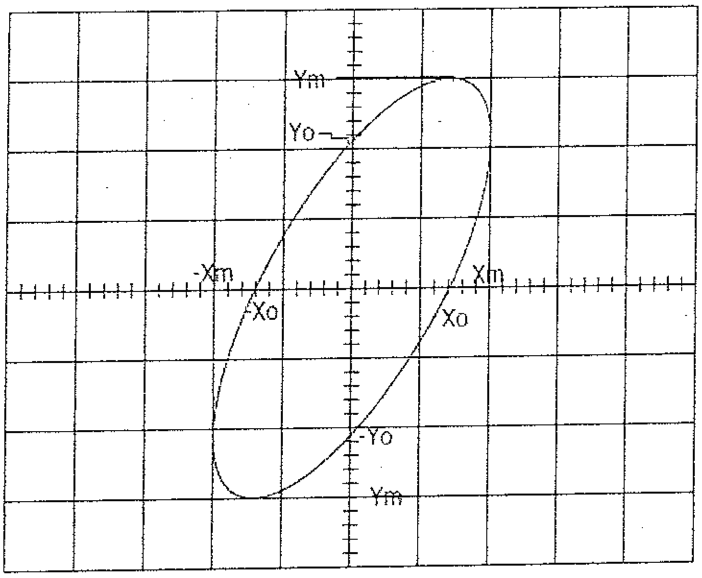


Figure 2

[2M]

5. Draw the block diagram of general purpose Cathode ray oscilloscope and explain the function of Trigger circuit and Delay line .Write only key points in your answer. [3M]

6. Draw the block diagram of Successive approximation type of A/D converter and form a bit testing sequence for a 4-bit converter. [2M]

Qn1 Fully open Valve Corresponds to binary word 1111 1111

$$V_{out} = V_{ref}\left(b_1 2^{-n} + b_2 2^{-(n-1)} + \dots b_n 2^{-1}\right)$$

$$= \frac{N}{2^n} V_{ref}.$$

$$10V = V_{ref}\left[b_n 2^{-n} + b_{n-1} 2^{-2} + \dots + b_1 2^{-n}\right]$$

~~$V_{ref} = \frac{10}{1 \times 2^{-8} +}$~~

N ⇒ decimal equivalent of binary number.

$$V_{out} = \frac{255}{2^8} V_{ref}.$$

$$10 = \frac{255}{2^8} V_{ref} \qquad V_{ref} = \frac{10 \times 2^8}{255}$$

$$= 10.039\,V \longrightarrow (1M)$$

The % of the valve opening for 1bit change Corresponds to value of LSB.

$$\Delta V_{ref} = \frac{V_{ref}}{2^8} = \frac{10.039}{256} = 0.0392V.$$

$$\Rightarrow \frac{100}{10\,V} \times 0.0392\,V$$

$$= 0.392\,\%$$ ——— (1M)

(iii) 0.1 %

$$1 \times 10^{-3} = \frac{V_{ref}}{2^{n}}$$

$$1 \times 10^{-3} \times 2^{n} = V_{ref}$$

$$2^{n} =$$

$$0.01 = \frac{V_{ref}}{2^{n}} = \frac{10.039}{2^{n}}$$

$$2^{n} = \frac{10.039}{0.01} = 1003.9$$

$$n(\log 2) = \log(1003.9)$$

$n = 10$. A bit DAC would serve the purpose.

——— (1M)

Qn2.

Voltage across R_2 resistance is

$$\frac{10k}{10k + 10k} \times 100V = 50V.$$

This is the true Voltage across R_2.

Case 1 :- using a Voltmeter having a sensitivity of $1000\Omega/V$.

it has a resistance of $1000 \times 50 = 50k\Omega$ on its 50V range.

Connecting the meter across R_2 Causes an equivalent parallel resistance given by.

$$R_{eq} = \frac{10k \times 50k}{10k + 50k} = \frac{500M}{60k} = 8.33k\Omega.$$

$$V_1 = \frac{R_{eq}}{R_1 + R_{eq}} \times V = \frac{8.33k}{10k + 8.33k}$$

$$= 45.43V.$$

Hence this voltmeter indicates 45.43V. — (1M)

using a voltmeter having sensitivity of $20,000\Omega/V$.

$$20,000 \times 50 = 1000k = 1M\Omega.$$

$$R_{eq} = \frac{10k \times 1M}{10k + 1M} = 9.9k\Omega.$$

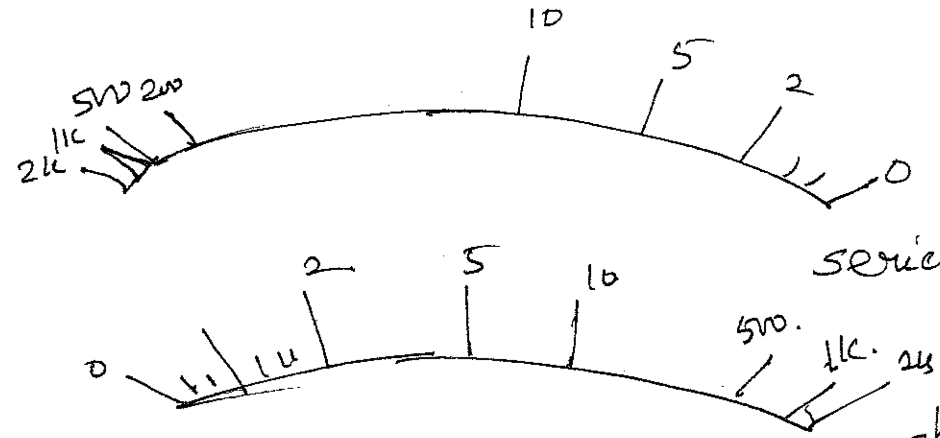
Voltage across the total Combination:

$$V_2 = \frac{99k}{10k+99k} \times 100V = 49.74 V.$$

Hence this Voltmeter reads 49.74 V. —— 1M

Comment :- High sensitivity Voltmeter should be used to get accurate readings. —— 1M

(3)



series scale. —— ½M

shunt scale —— ½M

(4) Series type ohmmeter – Scale starts with infinity at left side and zero at right side. —— ½M

Scale in shunt type ohmmeter – Scale starts with zero at left side & infinity at right side —— ½M

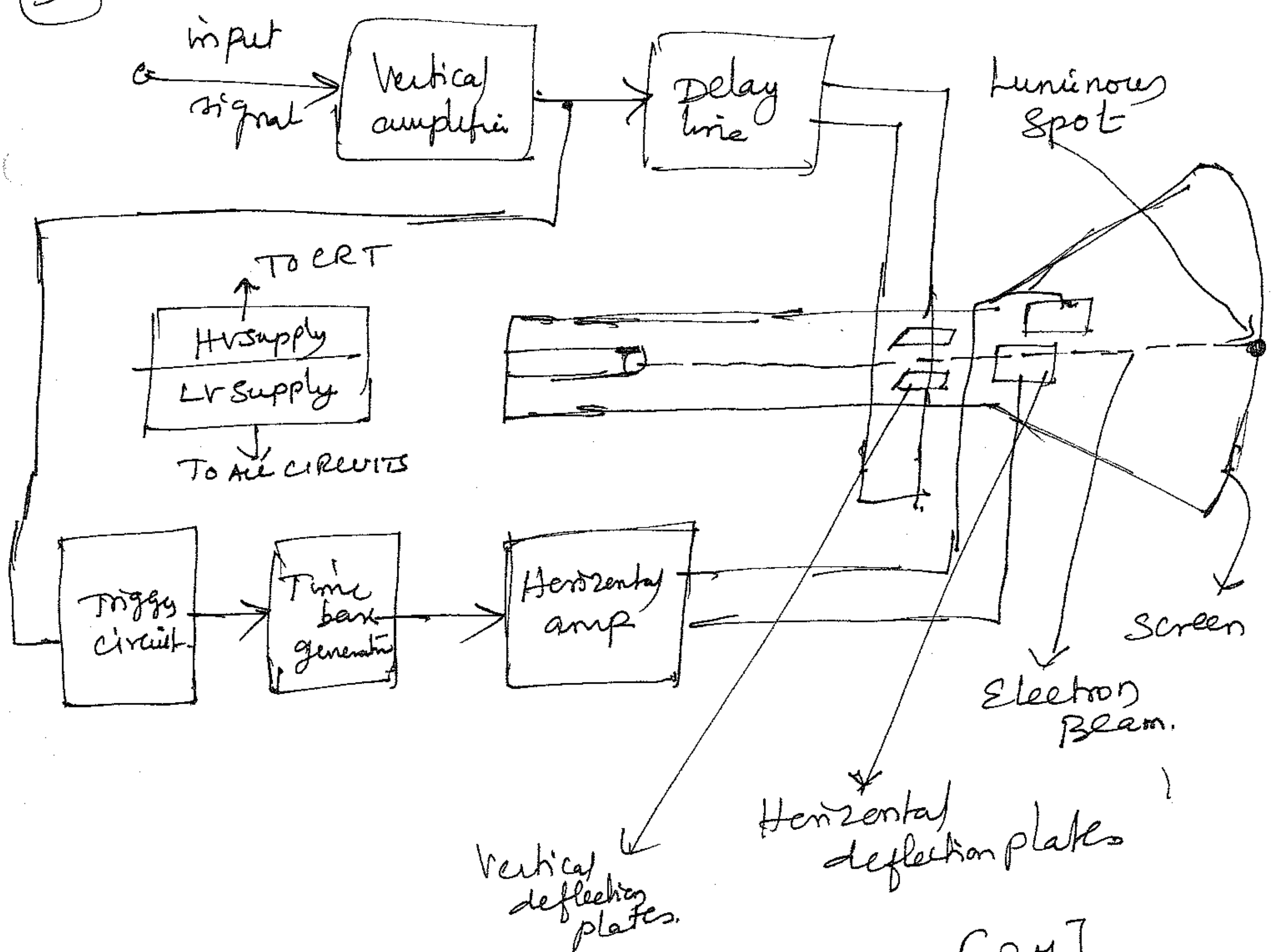
(4) $Ym = 3\,cm$ $Y_0 = 2.1\,cm$ $Xm = 2\,cm$ $X_0 = 1.4\,cm$ Pg 5

$-Ym = -3\,cm$ $-Y_0 = -2.1\,cm$ $-Xm = -2\,cm$ $-X_0 = -1.4\,cm$ (1M)

$\sin\theta \Rightarrow \frac{2.1}{3} = 0.7$

$\theta = 44°$ → 1M.

(5)

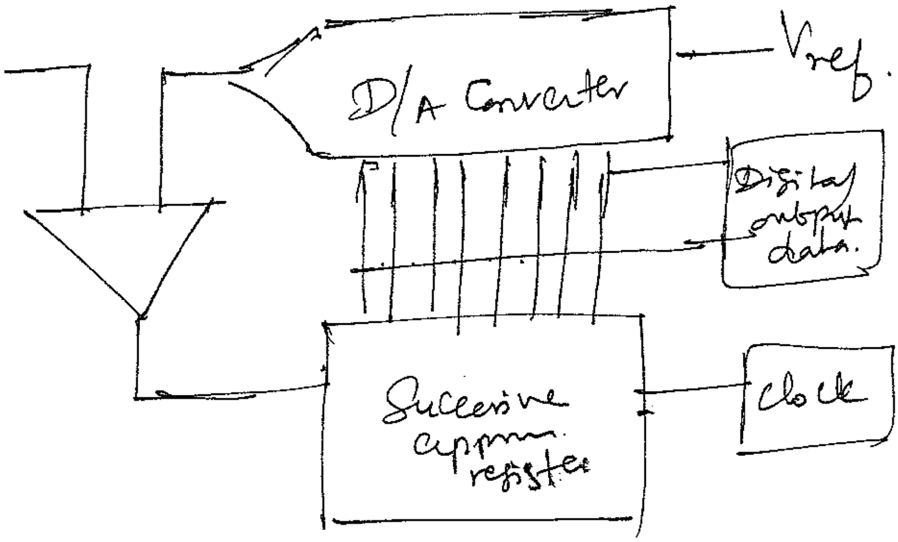


[2M]

Trigger ckt → used to convert the incoming signal into trigger pulses so that the input signal & sweep frequency can be synchronized [½M]

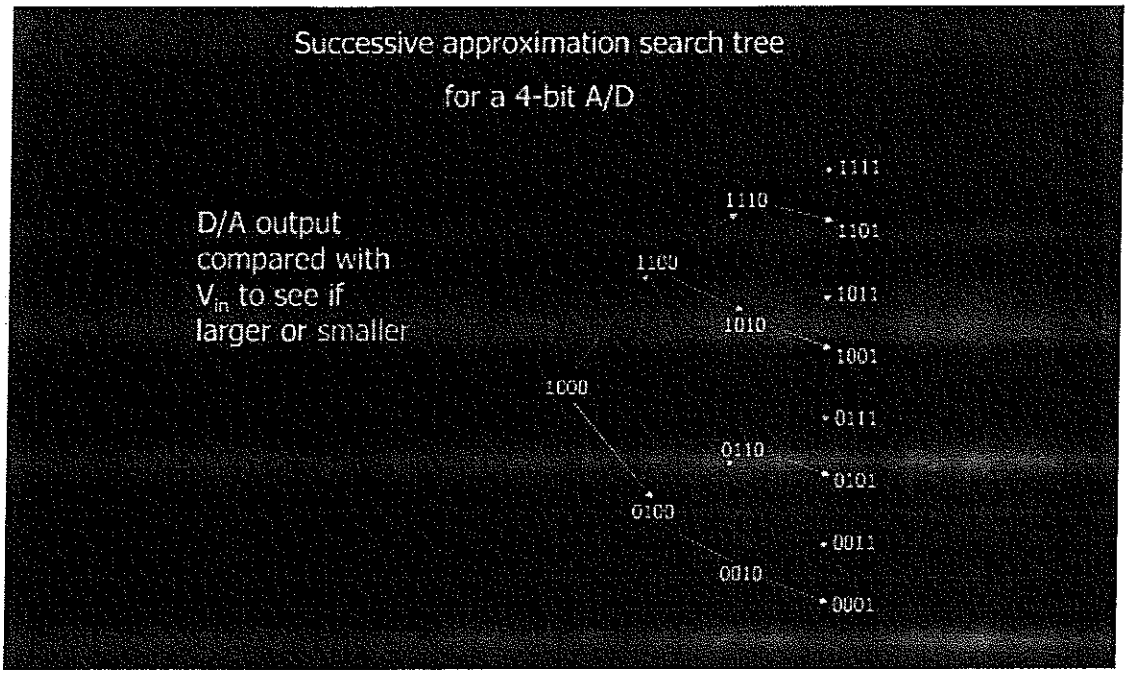
Delay line → used to delay the signal in vertical section [½M]

(6) Successive approximation



1½M

1M


Successive approximation search tree
for a 4-bit A/D
D/A output compared with V_{in} to see if larger or smaller
1111
1110
1101
1100
1011
1010
1001
1000
0111
0110
0101
0100
0011
0010
0001

[1M]

EIIT

BITS, PILANI – DUBAI CAMPUS

II SEM 2012 – 2013

Course Code: INSTR C355 **Date: ~~4~~3.03.2013**
Course Title: EIIT III YEAR EIE **Max Marks: 8**
Duration: 20 Minutes **Weightage: 8%**
Component: QUIZ 1 (Closed Book)
ID NIMBER:................................. **NAME OF THE STUDENT:.................................**

ANSWER ALL QUESTIONS

1. What would happen to this meter movement, if connected directly to a 6-volt battery in Fig.1? Write two key points in your answer. [1M]

F.S. = 1 mA $R_{coil} = 400\ \Omega$

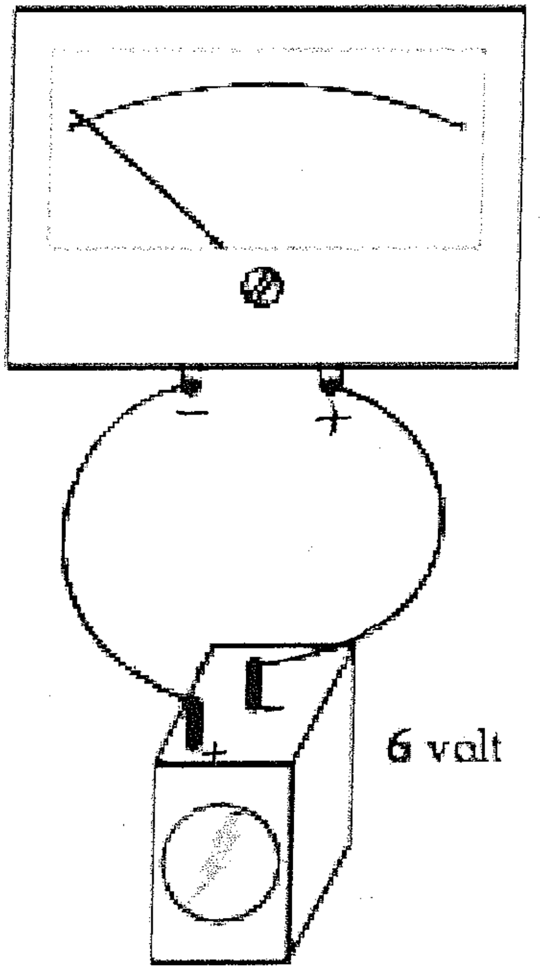


Fig.1

P.T.O

4. Why PMMC is used for dc only? Write only key points in your answer. [1M]

5. Explain what the ohms-per-volt sensitivity rating of an analog voltmeter means. Many analog voltmeters exhibit a sensitivity of 20 kΩ per volt. Is it better for a voltmeter to have a high ohms-per-volt rating, or a low ohms-per-volt rating? Why? [1M]

6. A technician picks up a resistor with the following color bands: Color code: **Org, Wht, Blu, Gld.** Having forgotten the resistor color code, and being too lazy to research the color code in a book, the technician decides to simply measure its resistance with an ohmmeter. Holding one lead of the resistor and one test lead of the ohmmeter between the thumb and index finger of the left hand, and the other resistor lead and meter test lead between the thumb and index finger of the right hand (to keep each test lead of the meter in firm contact with the respective leads of the resistor), the technician obtains a resistance measurement of 1.5 MΩ. What is wrong with the technician's measurement? [1M]

P.T.O

Answering scheme

BITS, PILANI – DUBAI CAMPUS

II SEM 2012 – 2013

Course Code: INSTR C355
Course Title: EIIT
Duration: 20 Minutes
Component: QUIZ 1 (Closed Book)
ID NIMBER:................................

III YEAR EIE

Date: 4.03.2013
Max Marks: 8
Weightage: 8%

NAME OF THE STUDENT:.................................

ANSWER ALL QUESTIONS

1. What would happen to this meter movement, if connected directly to a 6-volt battery in Fig.1? Write two key points in your answer. [1M]

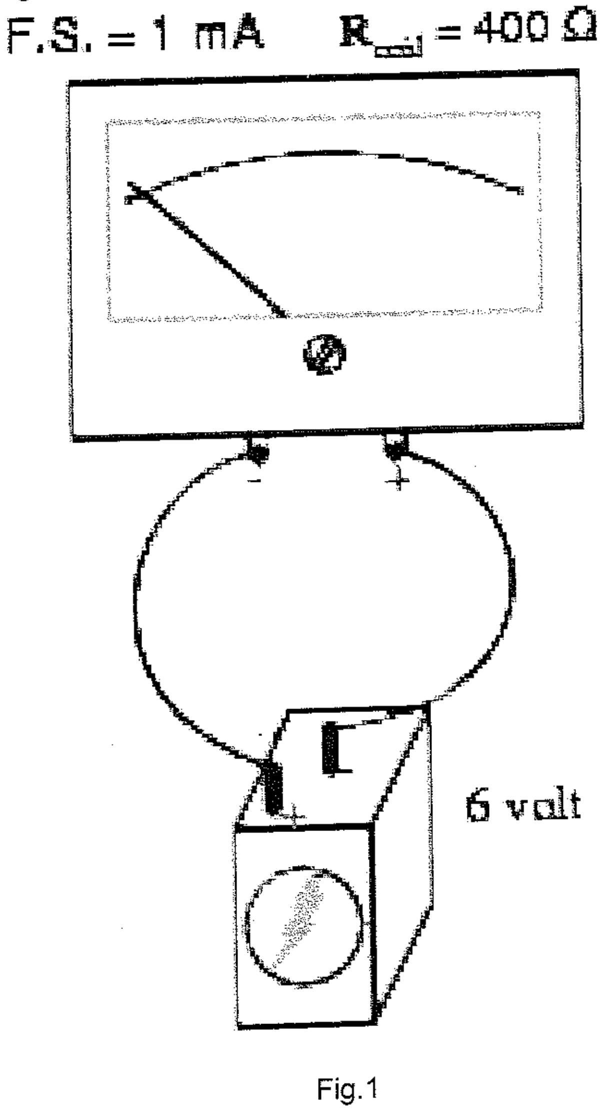


Fig.1

Two things would happen: first, the movement would most likely be damaged from excessive current. Secondly, the needle would move to the left instead of the right (as it normally should), because the polarity is backward.

[1M]
(only for key Points)

2. For the circuit shown below (Fig.2), write down an expressions for R_1 and R_2. [1M]

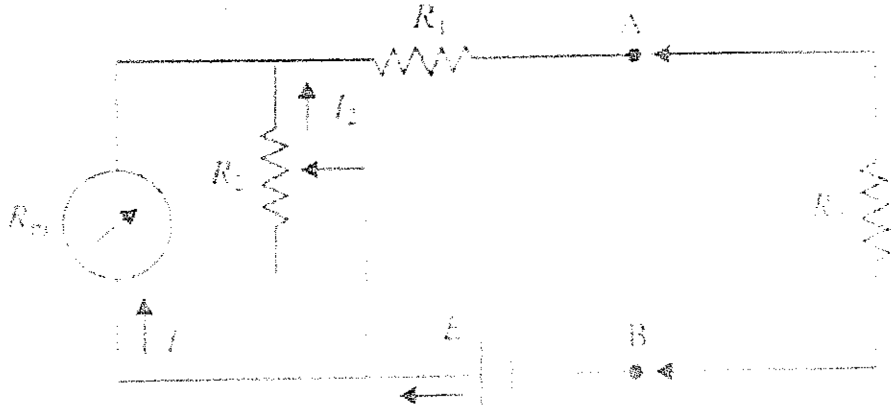


Fig.2

$$R_2 = \frac{I_{fsd} R_m R_h}{E - I_{fsd} R_h} \quad (½M) \qquad R_1 = R_h - \frac{I_{fsd} R_m R_h}{E} \quad (½M)$$

R_h → int resistance.

I_{fsd} → full scale deflection of current.

3. Calculate the necessary resistance values to give this multi-range voltmeter the ranges indicated by the selector switch positions (25V & 100V) in Fig.3. [1M]

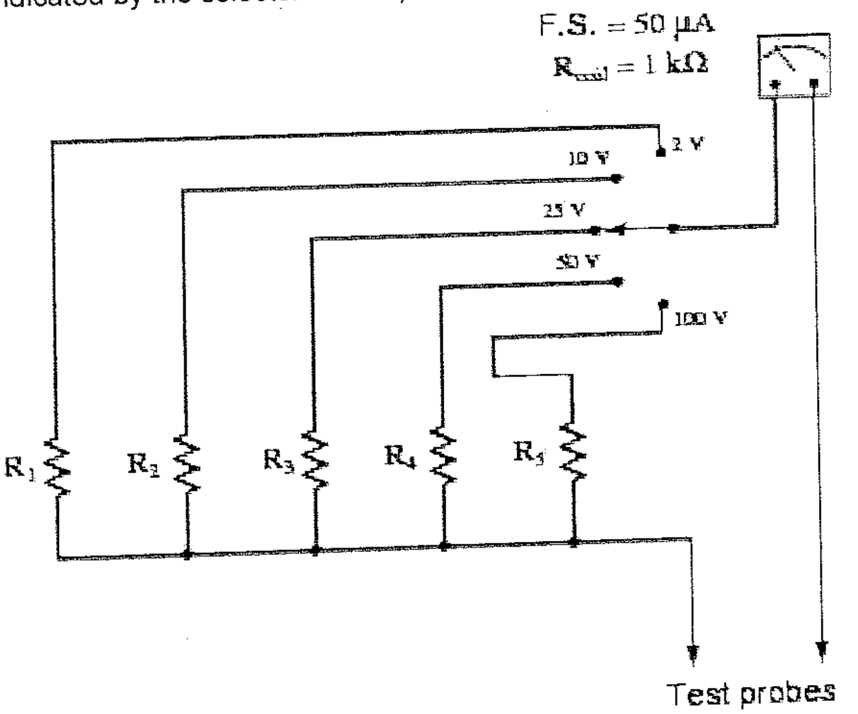


Fig.3

For 25V $R_3 = 499\,k\Omega$ ———— (½M)

$R_5 = 1.999\,M\Omega$ ———— (½M)

4. Why PMMC is used for dc only? Write only key points in your answer. [1M]

Because in the coil DC current follow easily and pmmc meter is making with coil and AC current is not follow in coil so we used the pmmc only for DC current.

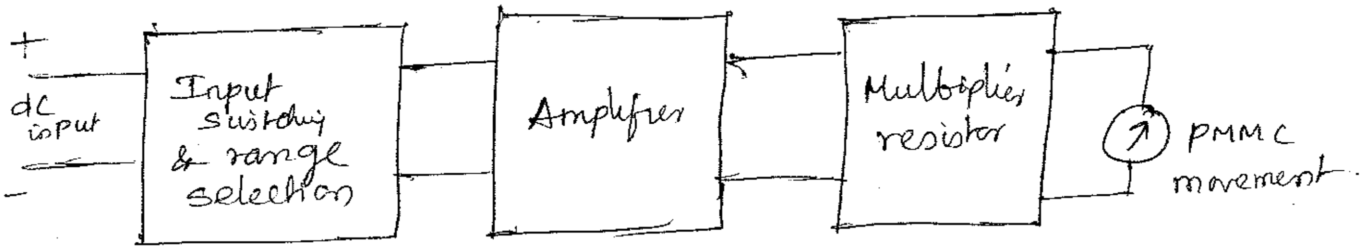
5. Explain what the ohms-per-volt sensitivity rating of an analog voltmeter means. Many analog voltmeters exhibit a sensitivity of 20 kΩ per volt. Is it better for a voltmeter to have a high ohms-per-volt rating, or a low ohms-per-volt rating? Why? [1M]

The öhms-per-volt" sensitivity rating of a voltmeter is an expression of how many ohms of input resistance the meter has, per range of volt measurement. The higher this figure is, the better the voltmeter.

6. A technician picks up a resistor with the following color bands: Color code: **Org, Wht, Blu, Gld.** Having forgotten the resistor color code, and being too lazy to research the color code in a book, the technician decides to simply measure its resistance with an ohmmeter. Holding one lead of the resistor and one test lead of the ohmmeter between the thumb and index finger of the left hand, and the other resistor lead and meter test lead between the thumb and index finger of the right hand (to keep each test lead of the meter in firm contact with the respective leads of the resistor), the technician obtains a resistance measurement of 1.5 MΩ. What is wrong with the technician's measurement? [1M]

The resistance measurement is much too low (it should be closer to 39 MΩ) because the Technician's body resistance is in parallel with the resistor.

7. Draw the block diagram of Electronic DC voltmeter. [1M]



8. Calculate the value of the multiplier resistor for a 10V rms range on the voltmeter shown in Fig. 4. [1M]

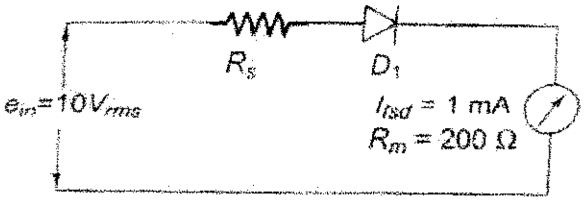


Fig. 4

$$R_s = 0.45 \frac{V_{rms}}{I_{av}} - R_m$$

$$= 0.45 \times \frac{10}{1 \times 10^{-3}} - 200$$

$$= \frac{0.45 \times 10}{1 \times 10^{-3}} - 200$$

$$= 4.3 \text{ k}\Omega$$