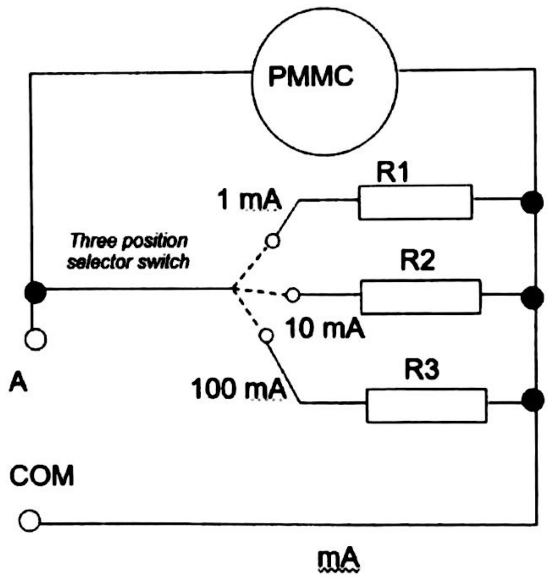
1st Key

University of Jordan
Electrical Engineering Department

Student Name (Arabic): | Student I.D:
Instrumentations and Measurements, EE 0903341 | *Second Term 2016/2017*
Date: 14/03/2017 | *Time: 1 hour*

Problem 1: [3 marks]
A PMMC with a full-scale deflection of 50 μA and an internal resistance of 2400 Ω and a 3-way rotary selector switch are used to build an analogue ammeter that can measure DC current in 3 ranges. The three ranges have full-scale deflections of 1 mA, 10 mA, and 100 mA. Find the values of the three resistors R_1, R_2, and R_3.



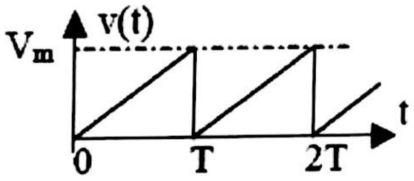
$\frac{1}{2}$ $R_1 = \frac{50\mu A\,(2400)}{1mA - 50\mu A} = 126.3\,\Omega$

$\frac{1}{2}$ $R_2 = \frac{50\mu\,(2400)}{10m - 50\mu} = 12.06\,\Omega$

$\frac{1}{2}$ $R_3 = \frac{50\mu\,(2400)}{100m - 50\mu} = 1.20\,\Omega$

Problem 3: [4 marks]

A signal generator with 500 Ω internal resistance is used to produce a saw tooth signal. The output of the generator is presented in the figure below. A moving coil voltmeter with internal resistance of 10 kΩ is used to measure the RMS of the generator output. The voltmeter uses a full wave rectifier and it is calibrated for sinusoidal waveforms. Calculate the total error in the rms measurement?



$$V_{rms} = \sqrt{\frac{1}{T}\int v^2(t)\,dt} = \sqrt{\frac{1}{T}\int_0^T \left(\frac{V_m}{T}\right)^2 t^2\,dt}$$

½ $$V_{rms} = \sqrt{\frac{V_m^2}{T^3}\,\frac{T^3}{3}} = \boxed{\frac{V_m}{\sqrt{3}}}$$

$$V_{avg} = \frac{1}{T}\int_0^T \frac{V_m}{T}\,t\,dt = \boxed{\frac{V_m}{2}}$$

½ AC signal $\Rightarrow$ $V_{rms} = \frac{V_m}{\sqrt{2}}$

$$V_{avg} = \frac{1}{\pi}\int_0^T V_m \sin\omega t\,dt = \frac{2V_m}{\pi}$$

factor $\Rightarrow$ $\frac{2V_m}{\pi} k = \frac{V_m}{\sqrt{2}}$

$$\boxed{k = \frac{\pi}{2\sqrt{2}} = 1.11}$$ ½

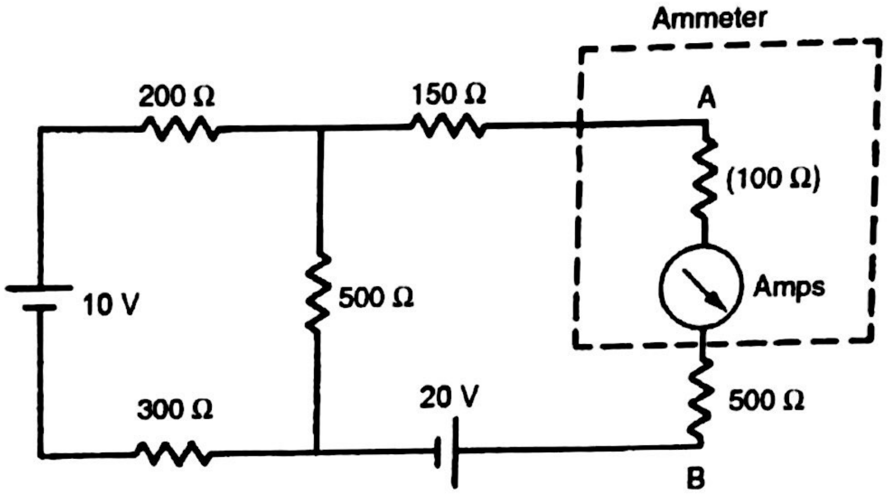
$$V_o = \frac{V_m}{2}(1.11) = 0.555\,V_m$$

$$\text{error} = \frac{\frac{V_m}{\sqrt{3}} - 0.555V_m}{\frac{V_m}{\sqrt{3}}} = 5\%$$ ½

Hamzeh Al-Rashdan (ID)
...ph Tu...

Problem 2: [4 marks]

In the circuit shown in the following figure, the current flowing between A and B is measured by an ammeter whose internal resistance is 100Ω. What is the measurement error (in %) caused by the internal resistance of the ammeter?



$R_{th} = (200+300) \,//\, 500 + 150 \Rightarrow 250 + 150 \Rightarrow$

$R_{th} = 400\Omega$

$V_{th} = \frac{(10)(500)}{1000} - 20 = -15V.$

1 $I_{act} = \frac{-15}{400+500} = -0.0167 A$

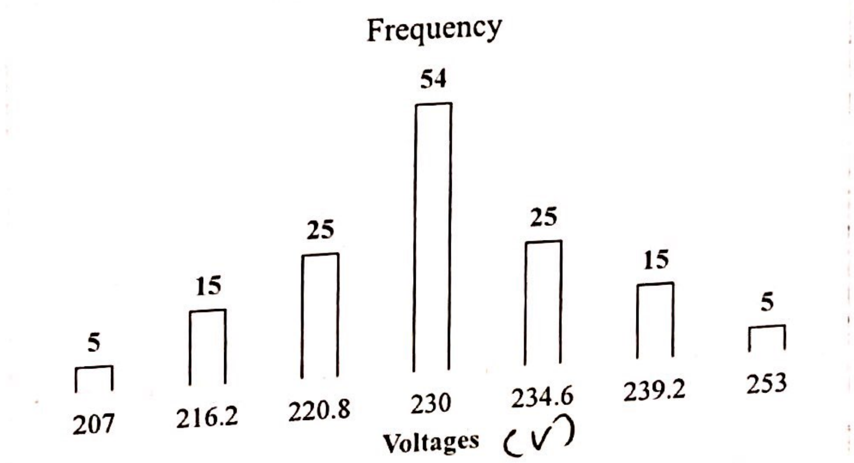
1 $I_{meas} = \frac{-15}{400+500+100} = -0.015 A.$

2 $|error| = \frac{-0.015 + 0.0167}{-0.0167} = |-10\%|$

$= 10\%$

Problem 5 [4 marks]: ABET

To understand the voltage variations at a house in winter season, voltage measurement instrument is used to collect voltages for one day. The voltage is recorded each 10 minutes. The statistical distribution of the results is shown in the figure below. By considering a confidence level of 95%, express the value of the voltage during winter season?



1/ $\bar{X} = 230\left(\frac{54}{144}\right) + 234.6\left(\frac{25}{144}\right) + 239.2\left(\frac{15}{144}\right) + 253\left(\frac{5}{144}\right) + 207\left(\frac{5}{144}\right) + 216.2\left(\frac{15}{144}\right) + 220.8\left(\frac{25}{144}\right) = 228.72\,V$

1/ $\sigma^2 = E[(x-\bar{x})^2] = \sum P_r (x_i - \bar{x})^2 = 82.125$

$\sigma = 9.06$

1/ $\alpha = \frac{\sigma}{\sqrt{n}} = \frac{9.09}{\sqrt{144}} = 0.755$

1/ $X = 228.72 \pm 1.96\,(0.755)$

$227.24 \leq X \leq 230.2$

Problem 4: [5 marks]

A digital meter has 3 ½ digital display and an accuracy of ±1.2% reading ± 3 counts is used to measure DC current. Its specification is presented in the Table below.

DC current range	Accuracy
200 μA	±1.2% reading ± 3 counts
2 mA	
20 mA	
200mA	

(a) What is the accuracy of the meter when it gives a reading of 1.234mA?

1/5. ±1.234 * 1.2% ± 3 * 0.001mA

±0.014808 ± 0.003 mA

(b) The meter shows a dc measurement of 1.711mA using the 2mA range. What is the error?

1/5. 1.2% (1.711) ± 0.01 * 3mA = ± 2.95%

(c) The 20 mA range is used to measure the same current as considered in part (b). What is the resulting increase in the error?

1/5. 1.2% (1.711mA) ± 3 * 0.1mA = 0.320532.

error = 18.7%

(d) This meter and a perfect resistor of 1 Ω (i.e. no error) are used as a power meter based on the calculation, $P=I^2R$. What is the maximum likely error in the power value using the 200 mA range?

2/5.

$$e = \pm\sqrt{\left(\frac{18.7}{100}\right)^2 + (18.7)^2} = 26.48\%$$

7/8

Problem 6 [3, 5 marks]:

Two sinusoidal voltages are applied to an oscilloscope in dual-trace operation. The vertical settings are 10mV/cm and 0.5V/cm for CH-1 and CH-2 respectively. The time base setting is 10ms/cm. Ch1 Ch2

(i) For the dual trace shown, find:

3

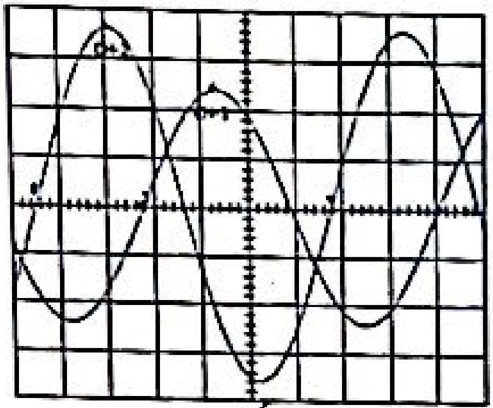
(a) The peak to peak values for voltages in CH-1 and CH-2

(b) The frequency of both signals

(c) The phase shift between V_1 (CH-1) and V_2 (CH-2). Does V_1 leads or lags V_2?

5 + 0.5 + 0.7

0.5 + 1 + 0.8



V_1 lag V_2

1 + 0.9 + 0.4

1.2

V_{ch_1} P-P $= 5 * (10mV)$
$= 50 mV$

V_{ch_2} P-P $= 7.2cm * (0.5 V/cm)$
$= 3.6 V$

$f = \frac{1}{T}$

$T_{ch_1} = 6.2 cm * (10ms/cm)$
$= 62 ms$

$T_{ch_2} = 6.2 cm (10ms/cm)$
$= 62 ms$

$f_{ch_1} = 16.12 Hz$

$f_{ch_2} = 16.12 Hz$

$\Theta = 2.3 * \frac{360}{6.2} = 133.5°$

V_1 lag V_2

$V_2 = 1.75 \sin(\omega t \ldots)$

:/5

(iii) If the oscilloscope is switched to XY mode of operation, V_1 is connected to the X input with setting (10mV/cm) and V_2 is connected to the Y input with setting (0.5V/cm). Draw the resulting graph, and mark on the graph all the corresponding values (e.g., minimum, maximum and zero crossing points)

maximum value

Y_{max} V_1 = 25 mV

Y_{max} V_2 = 1.84 V

minimum value

Y_{min} V_1 = -25 mV

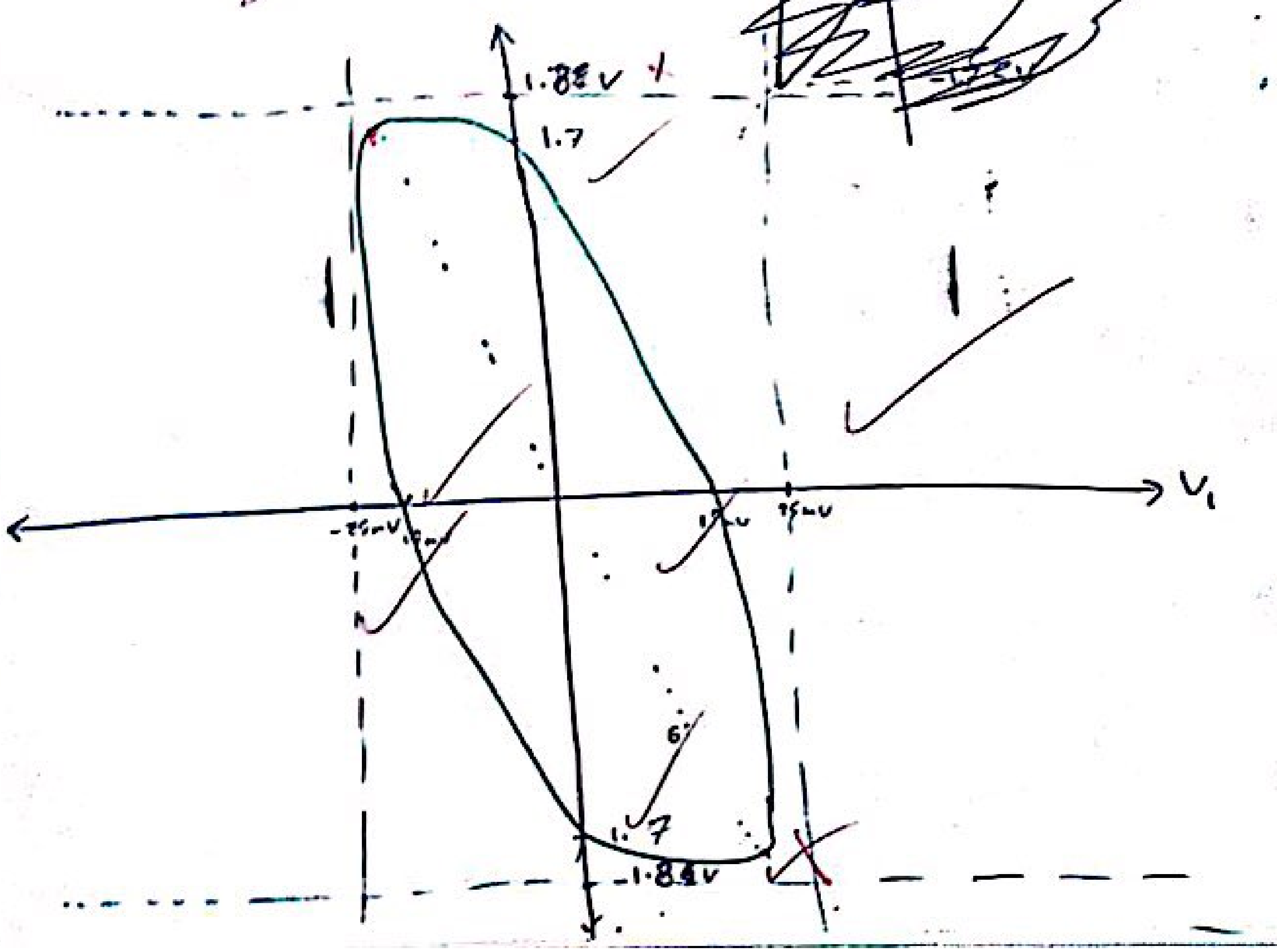
Y_{min} = V_2 = 1.84 V

$X_0 = 19$ mV

$Y_0 = 1.7$ V

$X_0 = -19$ mV

$Y_0 = 1.7$

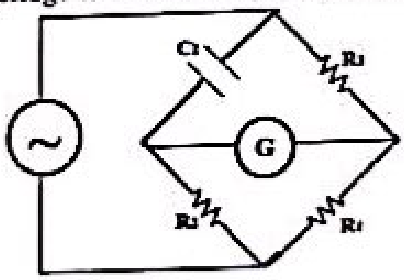


26/30

University of Jordan
Electrical Engineering Department

Student Name (Arabic): محمد اخليل كوامتة **Student I.D:** 0142208
Electrical measurements and instruments, EE 0933341 *First Term 2016/2017*
Date: 30/11/2016 *Time: 90minutes*

Problem 1 [2 marks]:
Explain why the following bridge circuit can never achieve balance condition



$\frac{R_2}{X_1} = \frac{R_4}{R_3}$

$\frac{R_2}{1/\omega c_1} = \frac{R_4}{R_3} \Rightarrow (\omega c_1) R_2 R_3 \neq \frac{R_4}{Real}$

Real + Imaginary imposipal.

because the ~~volt~~ voltage drop acros C_1 is not equal the voltage drop in R_3.

the impedance in 1 branch is imeganary and hats not imegnary part in authorside

Problem 2 [3, 2 marks]:

(i) In the context of Cathode Ray Tube (CRT) oscilloscope, explain the purposes of the following components: Delay line, Sweep circuit, HV supply

Deley line → to syncronic the V plats and H plats working and this is by delay the V signal at the swiping time prosisng

Sweep circuit → matching the start point of H signal to H plats and generat the sawtooth

HV supply: to supply the CRT to generat the Beam and, luminance and Focus. and this prosess take a H/V and H power to hebit the sink.

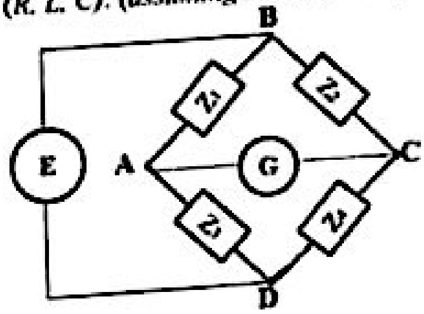
(ii) List two main differences between analog and digital oscilloscope

	analog	digital
1-	show the signal imidiatly at now time	save the signal and show it in any time.
2-	in low freq the spot scale has slow and can trace this in human eye	in low freq the plot is continuous and Fast.

(4)

Problem 4 (5 marks):

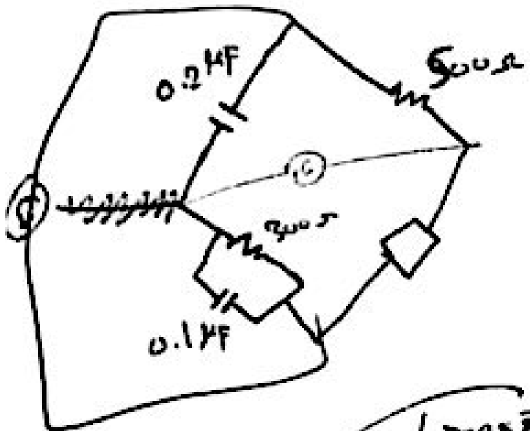
An AC bridge shown below is balanced at 1000 Hz and has the following constants: AB: 0.2 μF; BC: 500Ω (pure resistance); DA: R = 300Ω in parallel with C = 0.1 μF; CD: unknown. Find the Z value connected through the arm CD and determine the corresponding element(s) (R, L, C). (assuming series circuit).



$f = 1000$ Hz

$\omega = 2\pi f$

$= 6283.$



$$\frac{Z_3}{Z_1} = \frac{Z_4}{Z_2}$$

$$Z_3 Z_2 = Z_4 Z_1$$

$$\left(\frac{300 \times \frac{1}{j\omega 0.1\mu}}{300 + \frac{1}{j\omega 0.1\mu}}\right) 500\,\Omega = Z_4 \left(\frac{1}{j\omega 0.2\mu}\right)$$

$X_C = j\omega C$

$-1591.55j$

$-795.77j$

$$Z_4 = 34.3 + 182.029j$$

$Z_4 \Rightarrow R_R = 34.3\,\Omega$ ✓ $\quad l = 28.9$ mH ✓

R L

$F = 994.718 kHz$

$w = 2\pi F$

$F = 0.994\ MHz$

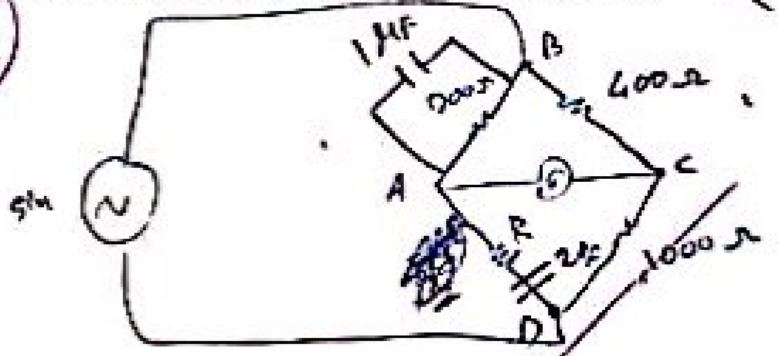
(5)

Problem 5 [2, 4 marks]:
The arms of a four-arm bridge ABCD supplied with a sinusoidal source have the following values: AB: 200Ω resistances in parallel with 1μF. BC: 400Ω resistance, CD: 1000Ω resistance, and DA: resistance R in series with capacitance 2μF.

(2)

(i) Draw the corresponding bridge and provide its type
(ii) Find the value of resistance R and the source frequency (under null condition)

(3)



Wine Bridge

for calculat the freq.

$$\frac{Z_3}{Z_1} = \frac{Z_4}{Z_2} \qquad Z_3 = \frac{Z_4 Z_1}{Z_2}$$

$$Z_{AD} = \frac{(1000)\left(\frac{200 \cdot \frac{1}{jw1\mu}}{200 + \frac{1}{jw1\mu}}\right)}{400}$$

$$F = \frac{1}{2\pi\sqrt{R_1C_1R_2C_2}}$$

$$R + \frac{1}{jw2\mu} = 2.5\left(\frac{\frac{200}{jw1\mu}}{200 + \frac{1}{jw1\mu}}\right)$$

$$R - j\frac{1}{w2\mu} = 2.5\left(\frac{200}{200(jw1\mu) + 1}\right)$$

$$R - j\frac{1}{w2\mu} = \frac{500}{jw200\mu + 1}$$

$$\underbrace{R\, jw200\mu}_{Im} + \underbrace{R + \frac{w200\mu}{w2\mu}}_{Real} - \underbrace{j\frac{1}{w2\mu}}_{Im} = \underbrace{500}_{Real} + \underbrace{j0}_{Im}$$

$$R + \frac{200}{2} = 500$$

$R = 400Ω$

$$R\, jw\, 200\mu = j\frac{1}{w2\mu}$$

$$w^2 = \frac{1}{(2\mu)(200\mu)R}$$

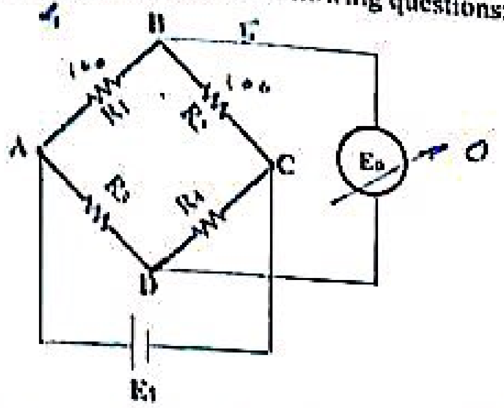
$w = 6.25$ M rad

$F = 994.71$ kHz

Scanned by CamScanner

Problem 3 [2, 2 marks]:

For the following Wheatstone bridge, answer the following questions:



(i) Determine the value of E_1, given that all resistances are 100Ω and the power consumption through R_1 is 0.25W (neglect meter resistance)

$P = VI = I^2R$ at $R_1 \rightarrow V = 5V$

$0.25 = \frac{V^2}{R}$ $I = 0.05A$

$E_1 = 10V$

(ii) Find E_o, given that E_1=5V and the resistor values of the Wheatstone bridge are: R_1= 200Ω, R_2= 400Ω, R_3= 500Ω, and R_4= 600Ω (neglect meter resistance)

$V_{DB} = E_1\left(\frac{R_3}{R_3+R_4} - \frac{R_1}{R_1+R_2}\right) = 0.606V$

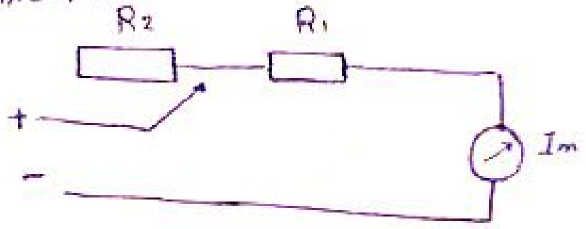
if deflection = 1mA / Rm = 10Ω

Design voltmeter to measure

① Range (0 – 10) V

② Range (0 – 50) V

* Find R_1, R_2

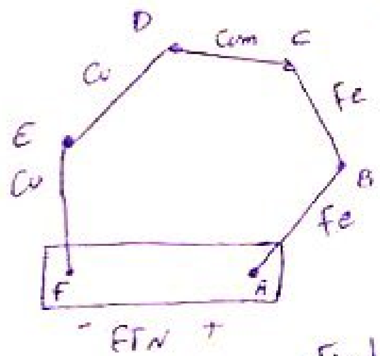


(5)

VB } given
VE
TA
TC
TD

given table

(8)



T	
Cu	
Fe	

Find other quantities and ETN

---

if we have ρ of soil, I fault, correction factor, safty factor

ρ

c

If

SF

(8)

Find V touch

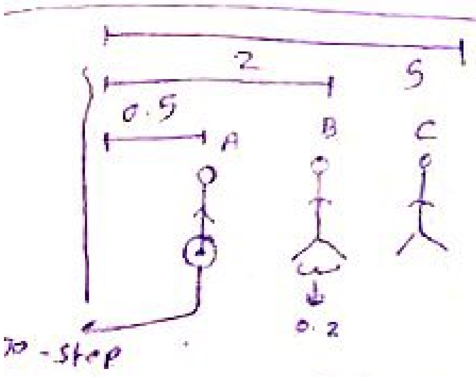
and Vstep

and Rg ⇒ [illegible]

GRP > V step, tough

Ig Rg.

ما عندي معطيات تكفي بالمعادلات الباقية



[illegible]

find VA, VB, Vc

Vstep :)

$V(x) = \frac{55}{X}$

↑ Voltage curve

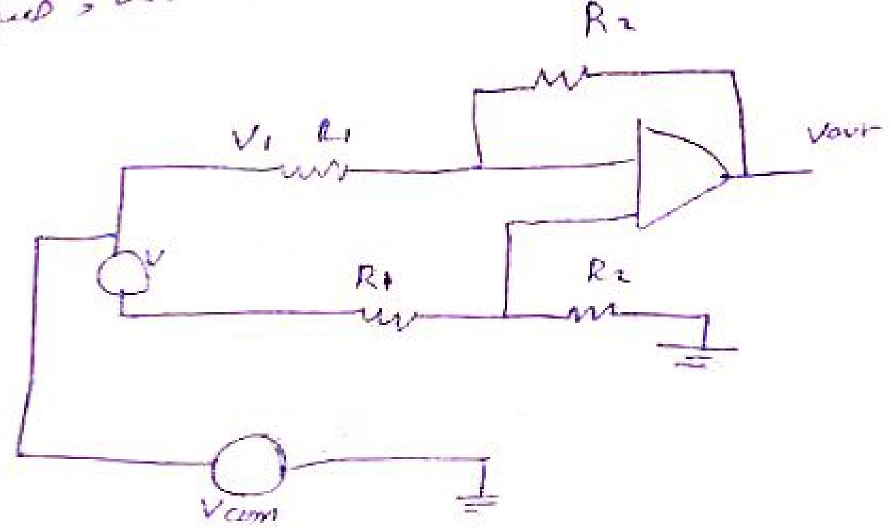
$$VA = 55\left(\frac{1}{X_1} - \frac{1}{X_1 + 0.2}\right)$$

[illegible]

في سؤال كان بدها نرسم ~~[illegible]~~ ال graph كيف بأثر common mode

اثر صيغة وتكتبي

المعادلات وصيغ



$$V_o = (V_1 - V_{com} - V_2 + V_{com})\,\frac{R_2}{R_1}$$

Without Common

$$V_o = (V_1 - V_2)\,\frac{R_2}{R_1}$$

انا كتبي من السلايدات

من المعادلات

- Multi range Ammeter → Add shunt R
- " " Voltmeter → " Series R
- Horizontal axis in ~~[illegible]~~ CRO is ____
- Principle of inductive transducer ① ②
- Application for PMMC
- disadvantage of PMMC

- adv for wien bridge
- disadv for hay bridge ~~[illegible]~~
- Transducer definition
- Block diagrams for linear and switched (section power supply)
- Transformer type in linear and switched — عليهم الكرتون سؤال
- First material

~~[illegible]~~

200 Ω ± 0.1 / 300 Ω ± 0.2 / 150 Ω ± 0.4 } → في كان واحد على نفس الشيء

find ε of meas equ R if there is connected in series

~~[illegible] battery and [illegible] battery~~ .

- ~~Two~~ example of rechargable and rechargable batter...