Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Second Year)

Subject: Physics

Course Code: PYS 101

Course Title: Network Analysis

Unit: 8 AC Bridges

Module Name: De Sauty's bridge and Wien's frequency bridge.

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Notes.

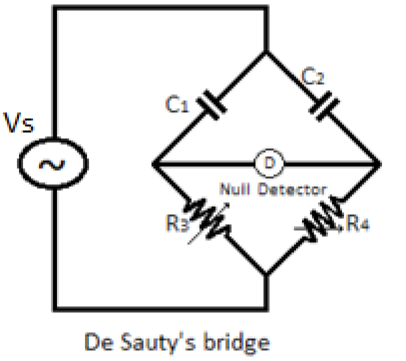
Measurement of Capacitance.
(De Sauty bridge, Schering bridge)

De Sauty'S bridge.
This bridge is used to determine the unknown capacitance by comparing it with known standard capacitor.
C_1 is the unknown capacitor and C_2 is a standard capacitor of known magnitude and R_3 and R_4 are known noninductive resistances.
The general equation of the bridge, $Z_1 Z_4 = Z_2 Z_3$

$Z_1 = 1/j\omega C_1$ $\quad Z_2 = 1/j\omega C_2$

$Z_3 = R_3 \quad Z_4 = R_4$

Substituting all the values in equation $Z_1 Z_4 = Z_2 Z_3$



De Sauty's bridge

$$(1/j\omega C_1)\, R_4 = (1/j\omega C_2)\, R_3$$

$$R_4/C_1 = R_3/C_2$$

$$C_1/C_2 = R_4/R_3$$

$$C_1 = C_2 R_4/R_3$$

For a given value C_2, R_4 or R_3 or both are to be varied to obtain balance conditions.

The equation is independent of frequency, The advantage of this bridge is its simplicity.
This equation assumes that the capacitances are ideal i.e. their leakage resistance are infinite and power factors are zero. This equation can be used for dielectric loss less capacitors like air capacitors.

Wien Frequency bridge. (RC frequency bridge)

The Wien bridge is mainly used to determine frequencies (audio- frequencies) of the voltage source in terms of known resistances and capacitances in the two arms of the bridge. In this bridge the values of all the parameters are known. It is also used as the feedback network in the wide range audio frequency oscillators. The circuit diagram is shown in Figure. The bridge has a series RC (R_1C_1)combination in one arm and a parallel RC (R_3C_3) combination in the adjoining arm. The remaining two arms contain pure non-inductive resistances (R_2, R_4).
General relation of the bridge balance $Z_1Z_4 = Z_2Z_3$

$Z_1 = (R_1+1/j\omega C_1)$ $\quad Z_2= R_2$
$Z_3 = (R_3/(1+j\omega C_3R_3)$ $\quad Z_4 = R_4$

$1/Z_3= 1/R_3 + I/(1/j\omega C_3)= 1/R_3 + j\omega C_3 = (1+j\omega C_3R_3)/R_3$

$Z_3= (R_3/(1+j\omega C_3R_3)$

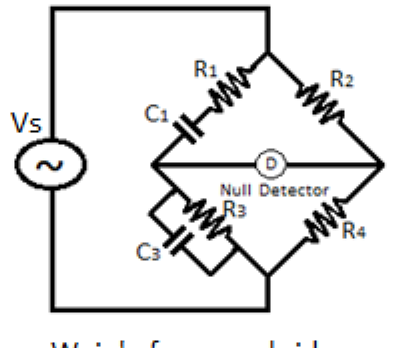
Substituting in the relationship for bridge balance
$(R_1 - j/\omega C_1)R_4 = R_2(R_3/(1+j\omega C_3R_3))$

$R_4(R_1- j/\omega C_1) (1+j\omega C_3R_3) = R_2R_3$

$(R_4R_1 - jR_4/\omega C_1) (1+j\omega C_3R_3) = R_2R_3$
$R_4R_1 - jR_4/\omega C_1 + R_4R_1j\omega C_3R_3 + (R_4C_3R_3/C_1) = R_2R_3$

separating the real and imaginary terms

$R_4R_1 + R_3R_4C_3/C_1 = R_2R_3$
$R_1/R_3 + C_3/C_1 = R_2/R_4$ ....1 Condition required resistance ratio
$- jR_4/\omega C_1 + R_4R_1j\omega C_3R_2 = 0$ $\quad 1/\omega C_1 = R_1\omega C_3R_2$



Wein's frquency bridge

$\omega^2 = 1/R_1R_2 C_1C_3$ $\omega = 1/\sqrt{R_1R_2C_1C_3}$

$f = 1/2\pi\sqrt{(R_1R_2C_1C_3)}$
condition required for determination of frequency of Vs.

For bridge balance both conditions have to be satisfied.
We choose
$R_1 = R_3 = R$, $C_1 = C_3 = C$ (ganged resistor, capacitor to have identical values)

$R_2/R_4 = 2$
$f = (1/2\pi RC)$ ---- general expression for frequency of Wien bridge

Note. Wien bridge being frequency sensitive, is difficult to balance unless the waveform of the applied voltage is purely sinusoidal.
Wien's bridge is also used in audio and radio frequency oscillators as a frequency determining element, in harmonic distortion analyser, as a notch filter. If frequency is known Wien bridge can be used to measure capacitance.