Measurement of Power in a single-phase AC load

Aim:

To measure the single-phase power in a single phase a.c. circuit by using three voltmeters.

Software Required:

LTspice Software

Circuit Diagram:

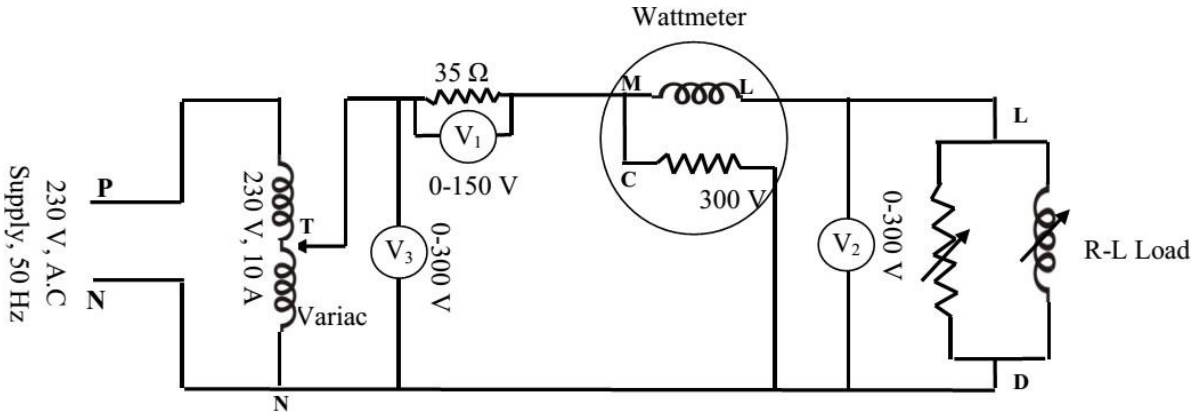


Fig. 1: Circuit Diagram

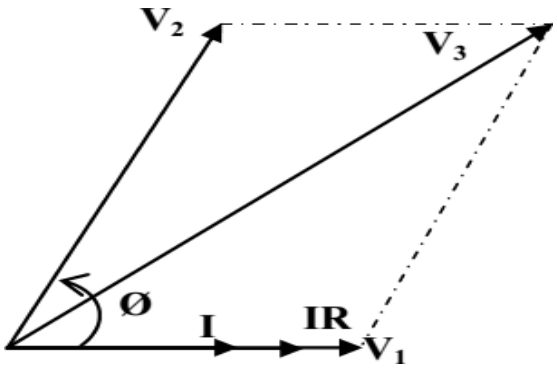


Fig. 2: Phasor Diagram

Theory:

Power consumed by load= $P=V_2 I \cos \emptyset$ (1)

From the phasor diagram we can write,

$V_3^2=V_1^2+V_2^2+2. V_1. V_2 \cos \emptyset$ (2)

Power factor, $\cos \emptyset= (V_3^2-V_1^2-V_2^2)/ 2. V_1. V_2$ (3)

$I=V_1/R$ (Here R= 35 Ohm)

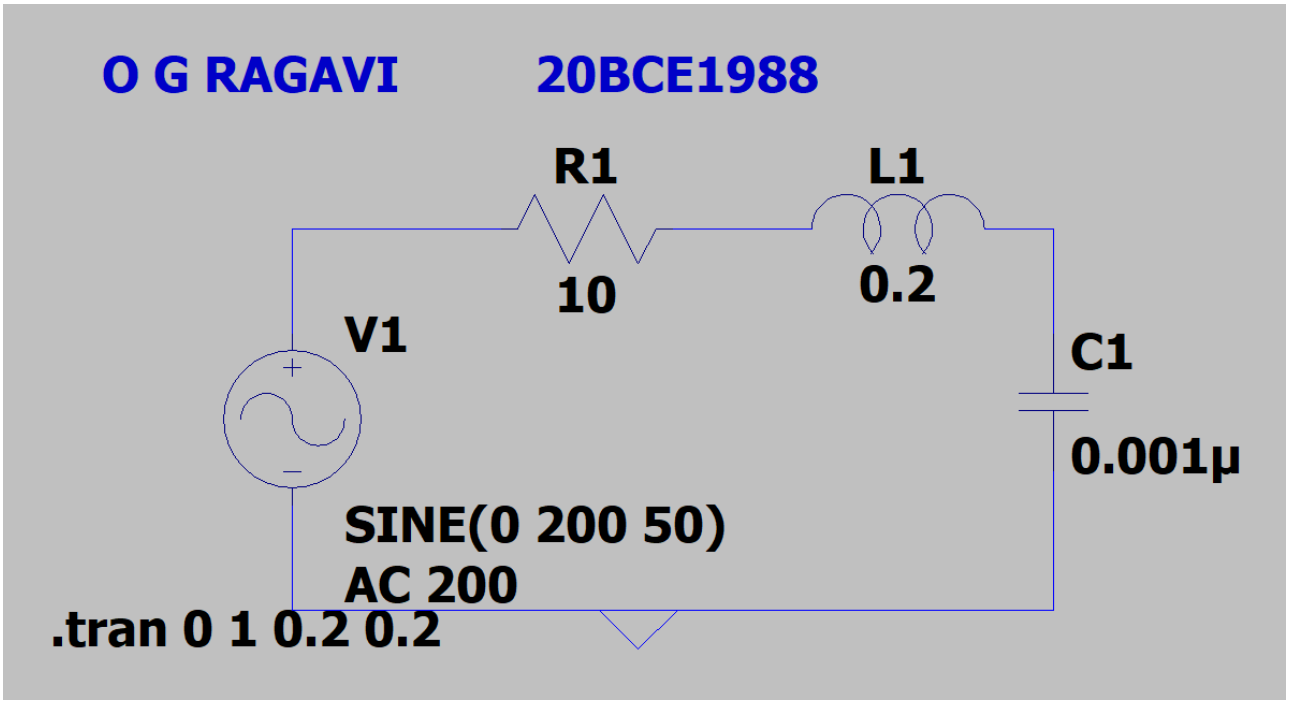
Now,

$P_{calculated} = V_2 I \cos \emptyset = V_2 (V_1/R) \cos \emptyset$

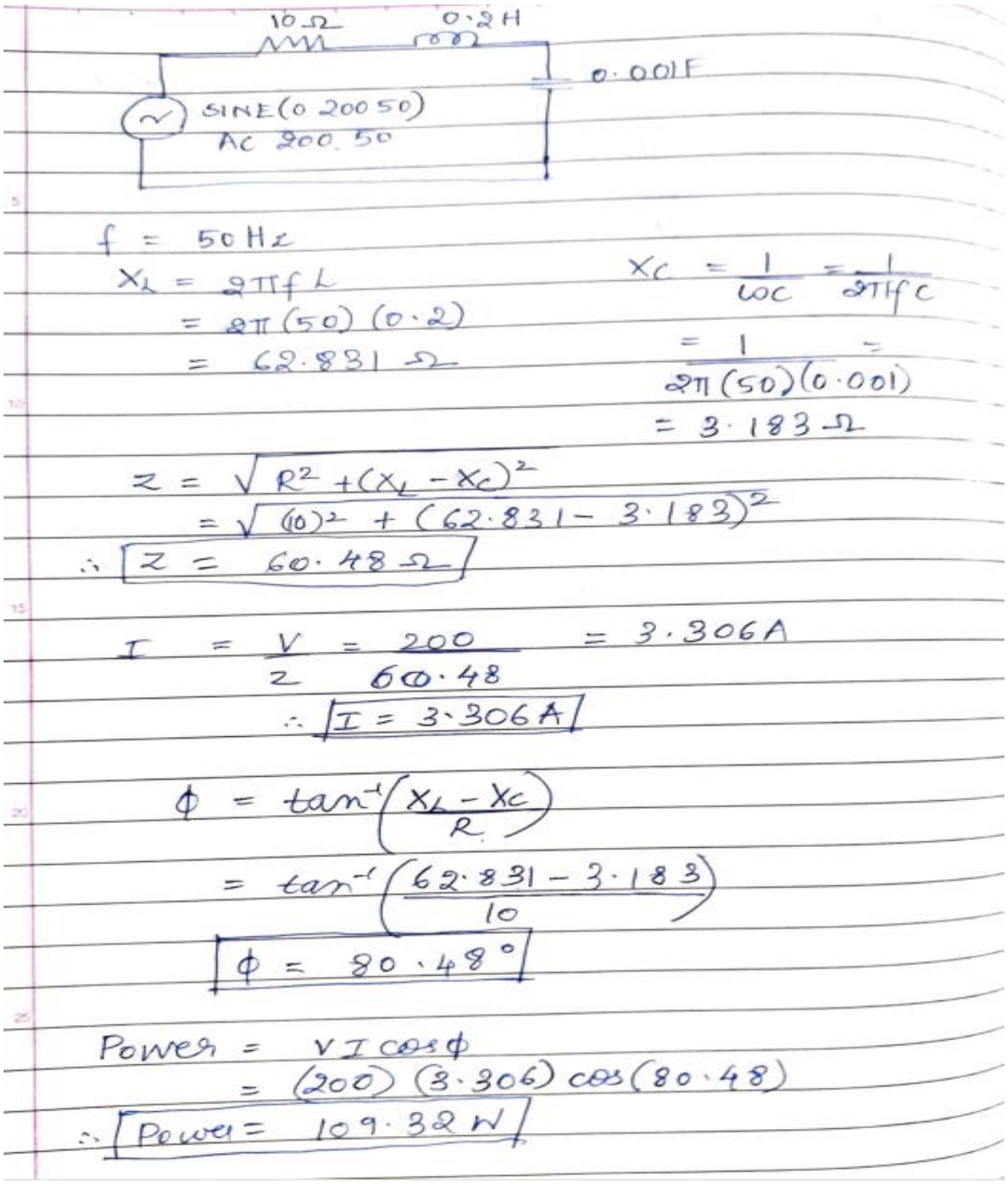
$= (V_1 V_2/R) ((V_3^2-V_1^2-V_2^2)/ 2. V_1. V_2) = (1/2R) * (V_3^2-V_1^2-V_2^2)$ (4)

From the above equation it can observed that, the power and power factor in an a.c circuit can be measured by using 3-single phase voltmeters, instead of a wattmeter.

Simulation:



Theoretical Calculation:



$f = 50\,Hz$

$X_L = 2\pi f L$

$= 2\pi(50)(0.2)$

$= 62.831\ \Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi(50)(0.001)}$

$= 3.183\ \Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

$= \sqrt{(10)^2 + (62.831 - 3.183)^2}$

$\therefore \boxed{Z = 60.48\ \Omega}$

$I = \frac{V}{Z} = \frac{200}{60.48} = 3.306A$

$\therefore \boxed{I = 3.306A}$

$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$

$= \tan^{-1}\left(\frac{62.831 - 3.183}{10}\right)$

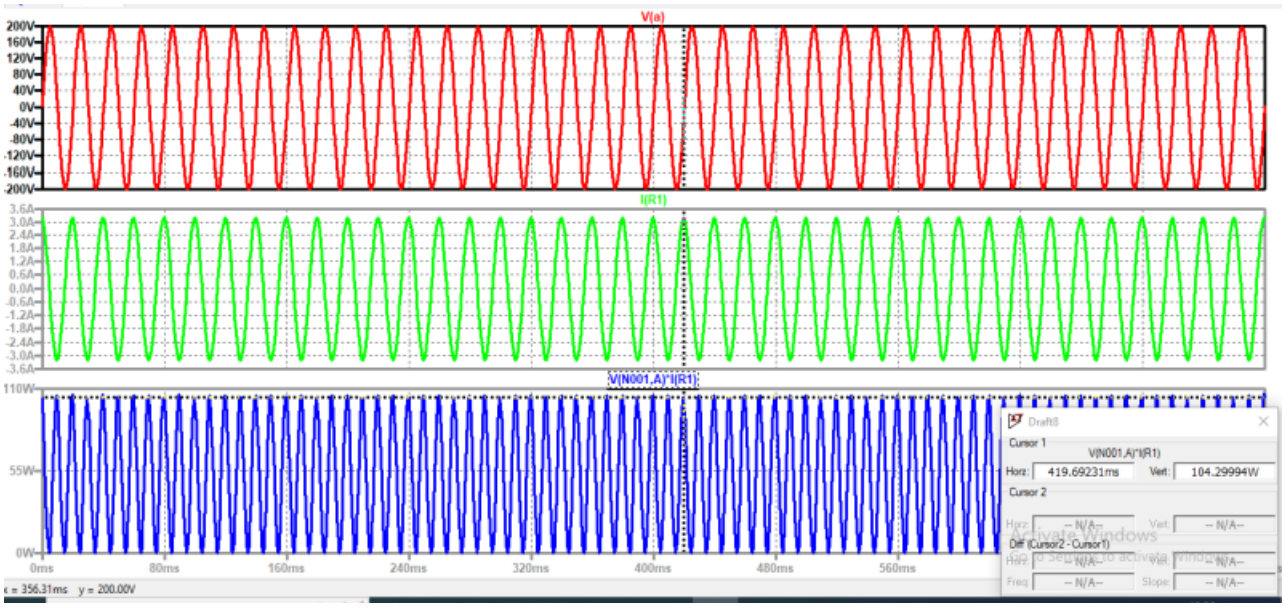
$\boxed{\phi = 80.48^\circ}$

$Power = VI\cos\phi$

$= (200)(3.306)\cos(80.48)$

$\therefore \boxed{Power = 109.32\ W}$

Simulation results:



Result:

Thus, The power in single phase ac circuit is measured successfully.