PVPP College of Engineering, Mumbai

Department of General Engineering

<u>End-Semester Test SH-2015</u>

Sem-1 All Branches Sub: BEEE Max. Marks: 20
Time: 9-30AM to 11AM Date: Oct. 29, 2015

Note: *(1) Q.1 is Compulsory, (2) Attempt any three questions from Q.2 to Q.5.*

(3) Each question carry 5 Marks. (4) Assume suitable data wherever required with proper justification

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Q1 Prove that the RMS value of a sinusoidal AC voltage source is 70.7 % of its peak value. Find the RMS value of a voltage signal whose instantaneous equation is given by:

$$v(t) = 50 + (100 \cdot sin(314t - \pi/6))$$

OR

Q1 A coil of 0.6 lagging power factor is connected in series with a 100μF Capacitor and the combined circuit is connected across a 50Hz frequency supply. The potential difference across the coil is equal to the potential difference across the capacitor. Find the Resistance and Inductance of the coil.

Q2 Explain with appropriate graph the vaiation of inductive reactance, capacitive reactance, impedance and power factor and circuit-current with reference to variation in frequency in a series R-L-C Circuit. Derive an expression for Bandwidth expressed in terms of Quality factor and Resonant frequency.

OR

Q2 A coil has a load impedance of $Z_c = 100\ \Omega$ with 0.866 lagging p.f. is connected across a a single phase 400V, 50 Hz Mains. Calculate value of a capacitor which would be connected across the coil so that the combined circuit current will be in phase with the supply voltage.

Q3 Two wattmeters are connected to measure power in three phase circuit. One of the wattmetrs reads 7kW when the load power factor is unity. If the load power factor is changed to 0.707 lagging without changing the total input power, calculate the readings of both the wattmeters

Q4 Prove the condition for maximum efficiency of a single phase transformer. Explain the reason why iron loss is called as constant loss and copper loss as variable loss in a transformer.

Q5 (a) Explain in brief the volt-ampere characteristics of p-n junction diode

Q5 (b) Prove that the instantaneous sum of three phase voltages for a balanced three phase system is zero.

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PVPP College of Engineering

Department of General Engineering

Sub:- BEEE, First Year Engineering

Paper Solution for End-Sem Exam

SH-2015

Q.1 $V_{rms} = \frac{V_m}{\sqrt{2}}$ for a Sinusoidal waveform

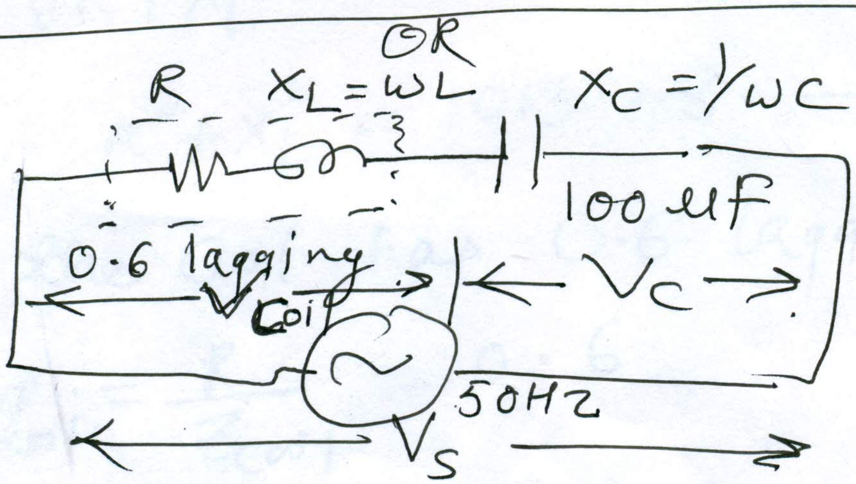
$$v(t) = 50 + 100 \sin(314t - \pi/6)$$

In general $= V_{dc} + V_m \sin(\omega t \pm \phi)$

$$\therefore V_{rms} = \sqrt{(V_{dc})^2 + \left(\frac{V_m}{\sqrt{2}}\right)^2} = \sqrt{V_{rms_1}^2 + V_{rms_2}^2}$$

$$= \sqrt{(50)^2 + \left(\frac{100}{\sqrt{2}}\right)^2} = \underline{\underline{86.6}} \text{ Volts}$$

Q.1



$V_{coil} = V_C$ To find R and L

(contd

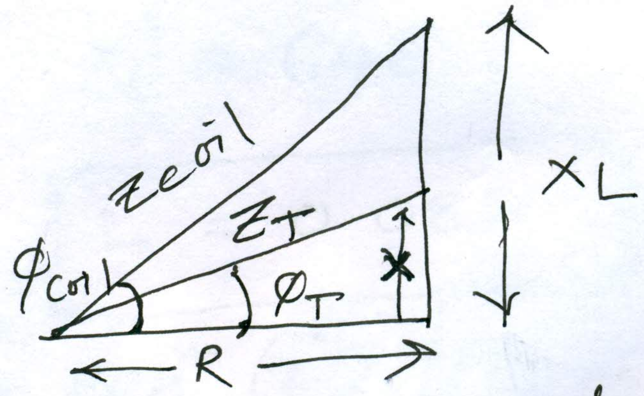
— OR —

Q. 7 _ Continued - - - -

$$Z_{coil} = R + jX_L = \text{Impedance of the coil}$$

$$Z_T = R + j(X_L - X_C) = \text{Total Impedance}$$

Let $X_L - X_C = X$



Since the current flowing through the coil and capacitor is the same

$$V_{coil} = V_{cap}$$

$$\therefore I Z_{coil} = I X_C$$

$$\therefore \sqrt{R^2 + X_L^2} = X_C = \frac{1}{\omega C} = \underline{\underline{31.84\,\Omega}}$$

$$R^2 + X_L^2 = 1013.78 \quad \text{—— (1)}$$

Since the coil has 0.6 lagging pf.

$$\cos\phi_{coil} = \frac{R}{Z_{coil}} = 0.6$$

$$\therefore R = 0.6\sqrt{R^2 + X_L^2}$$

$$\therefore R^2 = 0.36(R^2 + X_L^2) = 0.36R^2 + 0.36X_L^2$$

$\therefore R^2(1-0.36) = 0.36 X_L^2$

$\therefore R^2 = 0.5625 X_L^2$ —— 2

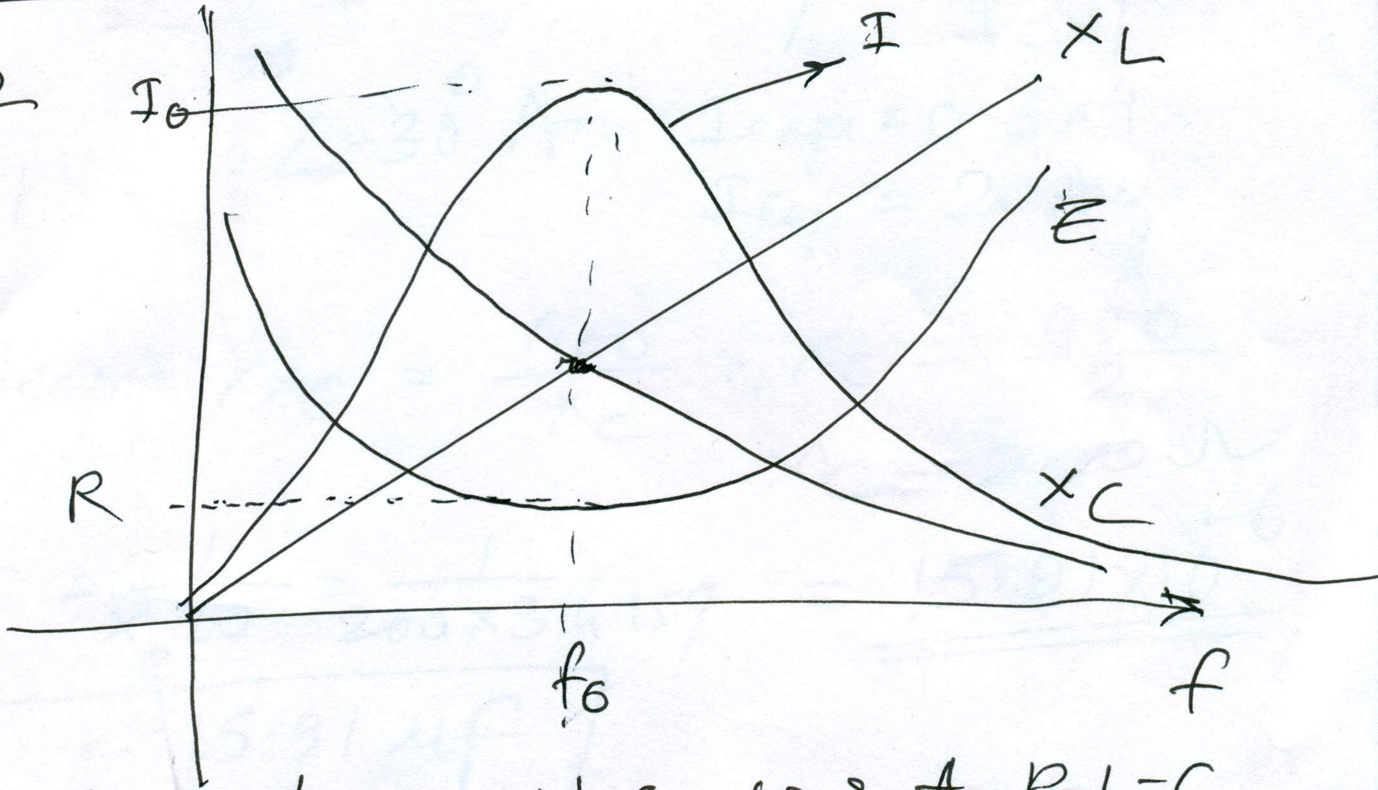
$\therefore$ Solving eqn 1 & 2

$X_L^2 = 648.8 \quad \therefore \boxed{X_L = 25.47\,\Omega}$

$\boxed{L = 0.08H}$

from eqn 2 $\boxed{R = 19.10\,\Omega}$

Q. 2



Different graphs w.r.t. R-L-C Series circuit

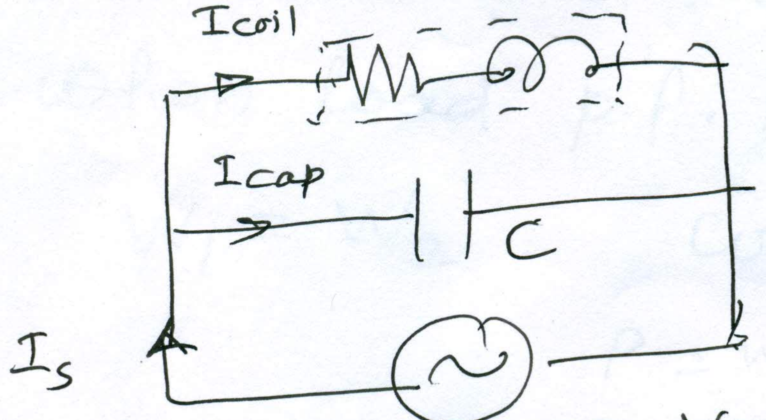
If Q = Quality factor $\quad f_0$ = Resonant Freq^n $\quad \Delta f$ = Bandwidth

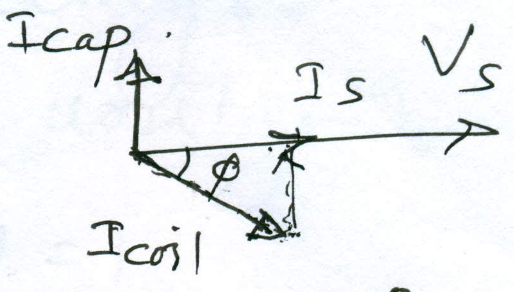
$\therefore \boxed{Q = f_0/\Delta f}$

(OR)

Q. 2

$Z_{coil} = 100\,\Omega$ $\cos\phi_c = 0.866$ lagg..





$\phi = 30°$.

$V_s = 400\,V, 50\,Hz$

$\cos\phi = 0.866$ laggiy.
$\phi = 30°$

$$I_{coil} = \frac{V_s \angle 0°}{Z_{coil} \angle 30}$$

$$= \frac{400}{100} \angle -30°$$

$$I_{coil} = 4 \angle -30° \text{ A}$$

$$\sin\phi = \frac{I_{cap}}{I_{coil}} = 0.5$$

$$I_{cap} = 0.5 \times 4$$

$$I_{cap} = 2 \text{ Amp.}$$

$$\therefore I_{cap} = V/X_C = \frac{400}{X_C} \quad \therefore X_C = \frac{400}{2}$$

$$X_C = 200\,\Omega$$

$$\therefore C = \frac{1}{X_C \omega} = \frac{1}{200 \times 314.159} = 15.91 \times 10^{-6}$$

$$\boxed{C = 15.91\,\mu F}$$

Q.3

Let W_1 and W_2 are two wattmeter readings when load p.f. is unity

$W_1 = W_2$ $\quad \cos\phi = 1$

$P = W_1 + W_2 = VI\cos\phi$

$Q = \sqrt{3}(W_1 - W_2) = 0$

$\therefore$ Total active Power $P = 7\,kW + 7\,kW$ $\quad \therefore W_1 = W_2 = 7\,kW$.

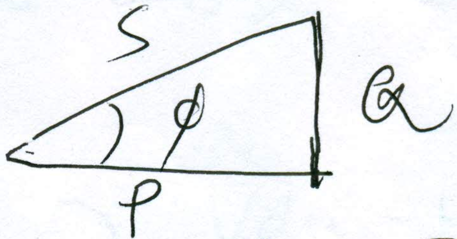
$= 14\,kW$.

New situation

$\Rightarrow$ If the load p.f. is changed to 0.707 lagging without changing the total input active power.

$\therefore P = 14\,kW. =$

if $pf = 0.707$ lagging.



$\phi = \cos^{-1}(0.707) = 45^\circ$

Power Triangle

$\therefore P = Q$ if $\phi = 45^\circ$

$\therefore W_1 + W_2 = 14\,kW$ ——— (1)

$\sqrt{3}(W_1 - W_2) = 14\,kW$. ——— (2)

From (1) & (2)

$$\begin{array}{r} W_1 + W_2 = 14 \\ W_1 - W_2 = 8.08 \\ \hline 2W_1 = 22.08 \end{array}$$

$$\boxed{\begin{array}{l} W_1 = 11\,kW \\ W_2 = 3\,kW \end{array}}$$

Q. 4 $\eta_{(tr)} = \frac{O/p}{O/p + \text{iron loss} + \text{Cu loss}}$

Let x = loading condition (p.u)

$$= \frac{KVA_{present}}{KVA_{FL}} = \frac{KVA_x}{KVA_{FL}}$$

Let $\cos\phi$ = load pf.

P_i = Iron loss

$P_{cu(x)}$ = Cu. loss at x loading state

$P_{cu(FL)}$ = Cu. loss at Full Load.

$$\therefore \eta = \frac{x\,KVA\cos\phi}{x\,KVA\cos\phi + P_i + x^2 P_{cu(FL)}} = \frac{u}{V}$$

Differentiate w.r.t. x

$$\frac{d\eta}{dx} = \cancel{x\,KVA\cos\phi}\ \frac{d(u/V)}{dx} = \frac{Vdu - udv}{V^2}$$

$= 0$ for max η

$\therefore Vdu - udv = \cancel{x}(KVA\cos\phi)[x\,KVA\cos\phi + P_i + x^2 P_{cuFL}]$

$- (KVA\cos\phi + 2x P_{cuFL})(x\,KVA\cos\phi)$

$= x[\cancel{KVA\cos\phi}]^2 + P_i\,KVA\cos\phi + x^2\,KVA\cos\phi\,P_{cuFL}$

$= x(\cancel{KVA\cos\phi})^2 + 2x^2\,KVA\cos\phi\,P_{cuFL}$

contd.....

$$\therefore \frac{d\eta_2}{dx} = 0$$

$$\Rightarrow P_i \, KVA \cos\phi + x^2 \, KVA \cos\phi \, P_{cuFL} = 2x^2 \, KVA \cos\phi \, P_{cuFL}$$

$$\therefore x^2 \cancel{KVA\cos\phi} \, P_{cuFL} = P_i \, \cancel{KVA\cos\phi}$$

$$\therefore \boxed{x = \sqrt{\frac{P_i}{P_{cuFL}}}} \quad \boxed{P_i = x^2 P_{cuFL}}$$

Since $x^2 P_{cu(FL)} = P_{cu(x)}$

$\therefore P_i$ = Iron loss = Cu. Loss at x loading state.

This is the condition of Max. efficiency &

$$x \text{ at } \eta_{max} = \sqrt{\frac{P_i}{P_{cuFL}}}$$

Q5 b Prove that the instantaneous sum of three phase voltages for a balanced three phase system is zero

let $e_a = V_m \cos \omega t$

$e_b = V_m \cos(\omega t - 120^\circ)$

$e_c = V_m \cos(\omega t + 120^\circ)$

be a voltage system for a three phase balanced system.

Representing the above state of equ^ns in polar form

$\vec{E_a} = V \angle 0^\circ$

$\vec{E_b} = V \angle -120^\circ$

$\vec{E_c} = V \angle +120^\circ$

$\vec{E_a} + \vec{E_b} + \vec{E_c}$ = Instantan sum / phaser sum

$= V[1 + j0] + V[-0.5 - j0.866]$

$+ V[-0.5 + j0.866] = 0$