Q1) Solved Eg. Type I (Q13) [R-L ckts.]

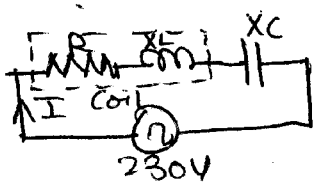
Q2) $R=10\Omega$, $L=0.1H$, $C=200\times10^{-6}F$, $V=230V$, $f=50Hz$

$X_L = 2\pi fL = 2\pi\times50\times0.1 = 31.42\Omega$

$X_C = 1/2\pi fC = 1\div(2\pi\times50\times200\times10^{-6}) = 15.92\Omega$

$Z = \sqrt{R^2+(X_L-X_C)^2} = 18.45\Omega$

$I = \frac{V}{Z} = \frac{230}{18.45} = 12.47A$



$Z_{coil} = \sqrt{R^2+X_L^2} = 32.97\Omega$

$V_{coil} = I.Z_{coil} = 411.17V$

$V_C = I.X_C = 198.52V$

At Resonance

$f_o = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.1\times200\times10^{-6}}} = 35.59Hz$

$I_o = \frac{V}{R} = 23V$

$X_{L_o} = 2\pi f_o L = 2\times\pi\times35.59\times0.1 = 22.36\Omega$

$X_{C_o} = 1/2\pi f_o C = 22.36\Omega$

$V_{C_o} = I_o X_{C_o} = 514.27V$

$Z_{coil_o} = \sqrt{R^2+X_{L_o}^2} = 24.49\Omega$

$V_{coil_o} = I_o Z_{coil_o} = 563.37V$

Q3) $R=50\Omega$, $C=50\times10^{-6}F$, $V=440V$, $f=50Hz$

$X_C = 1/2\pi fC = 1\div(2\pi\times50\times50\times10^{-6}) = 63.66\Omega$

$Z = \sqrt{R^2+X_C^2} = 80.95\Omega$

For Delta Connection:-

$V_L = V_{ph} = 440V$

(a) $I_{ph} = \frac{V_{ph}}{Z} = 5.44A$

(b) $I_L = \sqrt{3} I_{ph} = 9.42A$

(c) Power $= \sqrt{3} V_L I_L \cos\phi = \sqrt{3} V_L I_L \times R/Z$

$= \sqrt{3} \times 440 \times 9.42 \times 50/80.95 = 4,434.22W$

(d) Let $V_{RY} = 440\angle 0° = 440 + j0$

$V_{YB} = 440\angle -120 = -220 - j381.05$

$V_{BR} = 440\angle 120 = -220 + j381.05$

$I_R = \frac{V_{RY}}{Z} = \frac{440}{50 - j63.66} = 3.36 + j4.28$

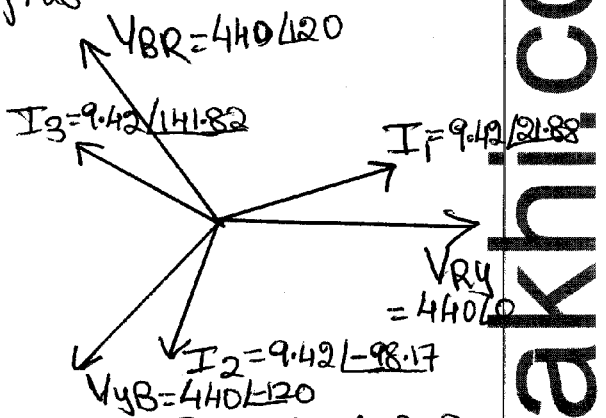
$I_Y = \frac{V_{YB}}{Z} = 2.02 - j5.05$

$I_B = \frac{V_{BR}}{Z} = -5.38 + j0.77$

$I_1 = I_R - I_B = 9.42\angle 21.88°$

$I_2 = I_Y - I_R = 9.42\angle -98.17°$

$I_3 = I_B - I_Y = 9.42\angle 141.83°$



Q4) $\phi = 45°$ (lag), $V_{Lm} = 2 \times V_{cm}$, $v_L = 300 \sin \omega t$, $R = 20\Omega$

$f = 50Hz$, (comparing with $v_L = V_{Lm} \sin \omega t$ $\therefore V_{Lm} = 300V$

$\therefore V_{cm} = V_{Lm}/2 = 150V$

$V_L = V_{Lm}/\sqrt{2} = 212.13V$, $V_C = V_{cm}/\sqrt{2} = 106.07V$

$V_L = IX_L \Rightarrow 212.13 = IX_L$ & $V_C = IX_C$ $\therefore 106.07 = IX_C$

$\therefore \frac{IX_L}{IX_C} = \frac{212.13}{106.07}$ $\therefore X_L = 2X_C$ ... (I)

$\cos\phi = \frac{R}{Z}$ $\therefore \cos 45^\circ = \frac{20}{Z}$ $\therefore Z = 28.28\,\Omega$

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

$\therefore Z = \sqrt{R^2 + X_C^2}$ $\therefore 28.28 = \sqrt{20^2 + X_C^2}$ $\therefore X_C = 20\,\Omega$

$X_L = 2X_C = 40\,\Omega$

$\because X_L = 2\pi f L$ $\therefore \boxed{L = 0.127\,H}$ & $X_C = \frac{1}{2\pi f C}$ $\therefore \boxed{C = 159.16\,\mu F}$

Q5) $V = 250V$, $I_1 = 5A$, $f_1 = 50Hz$, $f_2 = 60Hz$, $I_2 = 5.8A$

$Z_1 = \frac{V}{I_1} = \frac{250}{5} = 50\,\Omega$

$Z_1 = \sqrt{R^2 + X_{L_1}^2}$ $\therefore 50 = \sqrt{R^2 + (2\pi f_1 L)^2}$ $\therefore R^2 = 2500 - \frac{1}{4\pi^2(50)^2C^2}$ ... (I)

$Z_2 = \frac{V}{I_2} = \frac{250}{5.8} = 43.1\,\Omega$

$Z_2 = \sqrt{R^2 + X_{L_2}^2}$ $\therefore 43.1 = \sqrt{R^2 + (2\pi f_2 L)^2}$ $\therefore R^2 = (43.1)^2 - \frac{1}{4\pi^2(60)^2C^2}$ ... (II)

Equating eq. (I) & (II) $\therefore 2500 - \frac{1}{4\pi^2(50)^2C^2} = (43.1)^2 - \frac{1}{4\pi^2(60)^2C^2}$

$\frac{1}{4\pi^2(50)^2C^2} - \frac{1}{4\pi^2(60)^2C^2} = 642.39$ $\therefore C = 69.42\,\mu F$

Subs. in eq (I) $\therefore R = \sqrt{397.52}\,\Omega = 19.94\,\Omega$

$\cos\phi_2 = \frac{R}{Z_2} = 0.463$

$P_2 = VI_2\cos\phi_2 = 250 \times 5.8 \times 0.463 = 671.35\,W$

Q6) $V_R = 10V$, $V_L = 15V$, $V_C = 10V$

$V = \sqrt{V_R^2 + (V_L - V_C)^2} = 11.18\,V$

Q7) $\because v = V_m \sin\theta$ $\therefore 0.5V_m = V_m \sin\theta$ $\therefore \theta = 30^\circ$

$V_{rms} = \sqrt{\frac{1}{T}\int_{\theta_1}^{\theta_2} (V_m \sin\theta)^2 d\theta} = \sqrt{\frac{1}{2\pi}\int_{30^\circ}^{360^\circ} V_m^2 \sin^2\theta\, d\theta}$

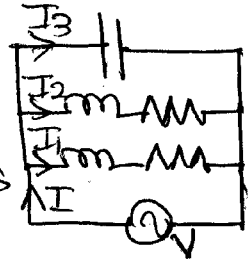
$V_{rms} = \frac{V_m}{\sqrt{2\pi}} \int_{30°}^{360°} \sin^2\theta \, d\theta = 70.77 V_m$

Q8) $I_1 = 20\angle 30° = 17.32 + j10$

$I_2 = 40\angle 60° = 20 + j34.64$

∴ Current through capacitor lags voltage by 90°

∴ $I_3 = I\angle -90° = -jI$



∵ $I = I_1 + I_2 + I_3 = 37.32 + j(44.64 - I)$

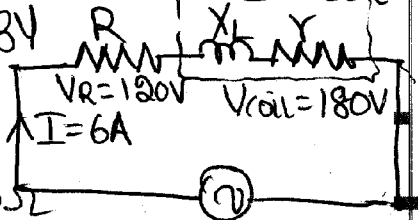
∵ P.f. of I is unity ∴ Its imaginary part is 0

∴ $44.64 - I = 0$ ∴ $I = 44.64A$

∴ Current through capacitor is $I_3 = -j44.64$

Q9) Let $V' = \sqrt{V_R^2 + V_{coil}^2} = 216.33V$

∵ $V' \neq 230V$ ∴ Coil is impure and has internal resistor r



∵ $V_R = I.R$ ∴ $120 = 6 \times R$ ∴ $R = 20\Omega$

∵ $V_{coil} = I.Z_{coil}$ ∴ $Z_{coil} = 180/6 = 30\Omega$

$Z_{coil} = \sqrt{X_L^2 + r^2}$ ∴ $30 = \sqrt{X_L^2 + r^2}$ ∴ $r^2 + X_L^2 = 900$ ... (I)

∵ $Z = V/I = 230/6 = 38.33\Omega$

∵ $Z = \sqrt{(R+r)^2 + X_L^2} = \sqrt{(20+r)^2 + X_L^2} = \sqrt{400 + 40r + r^2 + X_L^2}$

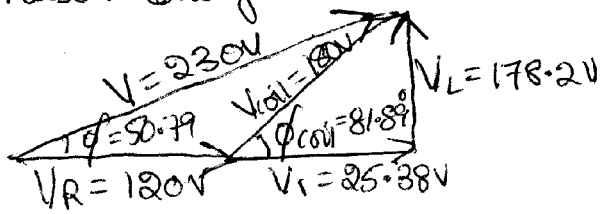
From eq (I) we get, $38.33 = \sqrt{400 + 40r + 900}$

∴ $r = 4.23\Omega$ Subs. in eq (I) ∴ $X_L = 29.7\Omega$

$V_r = Ir = 25.38V$, $V_L = I.X_L = 178.2V$

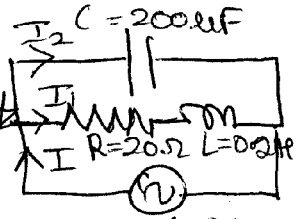
$\cos\phi_{coil} = r/Z_{coil}$ ∴ $\phi_{coil} = 81.89°$, $\cos\phi = \frac{R+r}{Z}$, $\phi = 50.79°$

Phasor diagram is:-



Q10) $R=20\Omega, L=0.2H, C=200\times10^{-6}F$

$f_0=\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{R^2}{L^2}}=$ ~~122.418Hz~~ 19.49Hz

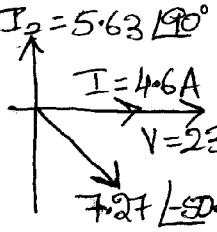


$Z_{dynamic}=L/RC=50\Omega$

$I=\frac{V}{Z_{dynamic}}=\frac{230}{50}=4.6A$

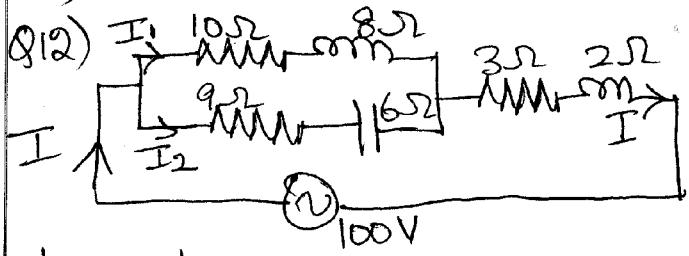
$I_1=\frac{V}{Z_{coil}}=\frac{V}{R+jX_L}=\frac{V}{R+j2\pi f_0 L}=4.6-j5.63=7.27\angle-50.77$

$I_2=\frac{V}{-jX_C}=\frac{V}{-j(1/2\pi f_0 C)}=+j5.63=5.63\angle90°$



Q11) Solved Eg. 8.14 [Polyphase ckts]

Q12)



$\frac{1}{Z_p}=\frac{1}{Z_1}+\frac{1}{Z_2}\quad\therefore\frac{1}{Z_p}=\frac{1}{10+j8}+\frac{1}{9-j6}$

$Z_p=(7.25-j0.13)\Omega$

$Z=Z_p+Z_3=(10.25-j2.13)\Omega$

$I=\frac{V}{Z}=\frac{100}{10.25-j2.13}=9.35+j1.94$

$V_p = I \cdot Z_p = (9.35 + j1.94)(7.25 - j0.13)$

$V_p = 68.04 + j12.85 = 69.24 \angle 10.69°$

$I_1 = \frac{V_p}{Z_1} = \frac{68.04 + j12.85}{10 + j8} = 4.78 - j2.54 = 5.41 \angle -27.97°$

$I_2 = \frac{V_p}{Z_2} = \frac{68.04 + j12.85}{9 - j6} = 4.58 + j4.48 = 6.4 \angle 44.39°$

$I_A = I_1 = 5.41 \angle -27.97°$

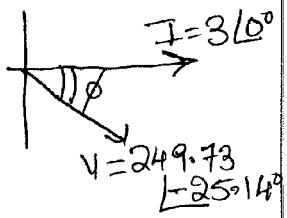
$I_B = I_2 = 6.4 \angle 44.39°$

Q13) $Z_1 = 50 \angle -45°$ { $\because$ pf = 0.707 (lead) $\therefore \phi = -45°$ }

$Z_1 = 35.36 - j35.36$

$Z_2 = 40\Omega$

$I = 3A$



$Z = Z_1 + Z_2 = 75.36 - j35.36$

$V = I \times Z = 3(75.36 - j35.36)$

$V = 926.08 - j106.08 = 249.73 \angle -25.14°$

$\therefore \phi = -25.14°$

phase angle = 25.14 (lead)

Q14) Total power = 1,500W

pf = 0.2 (lag)

V_L = 440V

f = 50Hz

For Star connection:-

$V_L = \sqrt{3}\, V_{ph}$

$\therefore V_{ph} = 254.03V$

Total power $= \sqrt{3} V_L I_L \cos\phi$

$1500 = \sqrt{3} \times 440 \times I_L \times 0.2$

$\therefore I_L = 9.84\ A$

$I_L = I_{ph} = 9.84\ A$

$Z_{ph} = \frac{V_{ph}}{I_{ph}} = 25.81\ \Omega$

$\cos\phi = \frac{R}{Z_{ph}} \quad \therefore R = 25.81 \times 0.2 = 5.16\ \Omega$

$Z_{ph} = \sqrt{R^2 + X_L^2} \quad \therefore X_L = 25.29\ \Omega$

$X_L = 2\pi f L \quad \therefore L = 0.0805\ H$

Q15) Solved Eqs Q5 [R-L-C ckts]

Q16) $e_1 = 25 \sin\omega t = \frac{25}{\sqrt{2}} \angle 0^\circ = \frac{25}{\sqrt{2}} + j0 = 17.68 + j0$

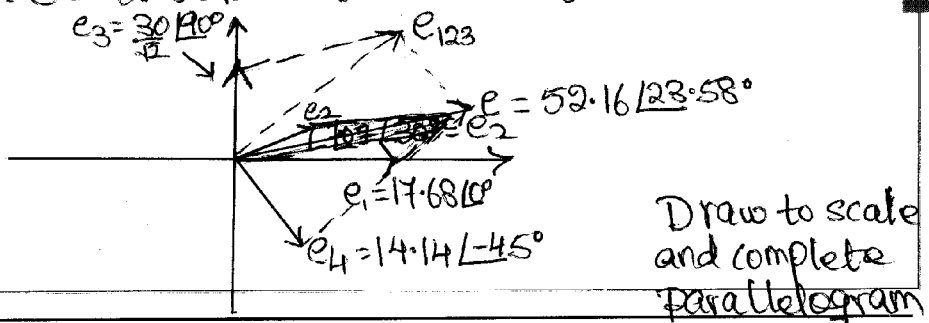
$e_2 = 10 \sin\left(\omega t + \frac{\pi}{6}\right) = \frac{10}{\sqrt{2}} \angle 30^\circ = 6.12 + j3.54$

$e_3 = 30 \cos\omega t = 30 \sin(\omega t + 90^\circ) = \frac{30}{\sqrt{2}} \angle 90^\circ = j21.21$

$e_4 = 20 \sin\left(\omega t - \frac{\pi}{4}\right) = \frac{20}{\sqrt{2}} \angle -45^\circ = 10 - j10$

$e = e_1 + e_2 + e_3 + e_4 = 33.8 + j14.75 = 36.88 \angle 23.58^\circ$

$\therefore e = 36.88\sqrt{2} \sin(\omega t + 23.58) = 52.16 \sin(\omega t + 23.58)$



Draw to scale and complete Parallelogram

Q17) Let $v = V_m \sin(\theta + \phi)$

On y-axis, $\theta = 0°$ and $v = 0.866 V_m$ (given)

$\therefore 0.866 V_m = V_m \sin(0 + \phi)$

$\therefore \phi = \sin^{-1}(0.866) = \pi/3$

$\therefore v = V_m \sin(\theta + \pi/3)$

Time period $= 2\pi - \frac{\pi}{3} = \frac{2\pi}{3}$

$$V_{avg} = \frac{1}{2\pi/3} \int_0^{2\pi/3} V_m \sin\left(\theta + \frac{\pi}{3}\right) d\theta$$

$$= \frac{3V_m}{2\pi} \left[-\cos(\theta + \pi/3) \right]_0^{2\pi/3}$$

$$= -\frac{3V_m}{2\pi} \left[\cos(\pi) - \cos\left(\frac{\pi}{3}\right) \right]$$

$$= -\frac{3V_m}{2\pi} \left[-1 - \frac{1}{2} \right] = +\frac{9V_m}{4\pi}$$

Q18) $Z\angle -\phi = R - jX_C$

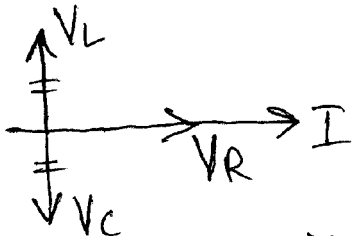
$\therefore$ Imaginary part of Z is negative because of negative phase angle

$\therefore$ Circuit is capacitive

For an capacitive circuit, imaginary part of Z is negative, since a circuit at resonance has only real part hence its imaginary part is zero therefore an inductor should be

added in series having $X_L = X_C$ hence $jX_L = jX_C$ hence positive imaginary part of inductor cancels with negative part of the capacitor.

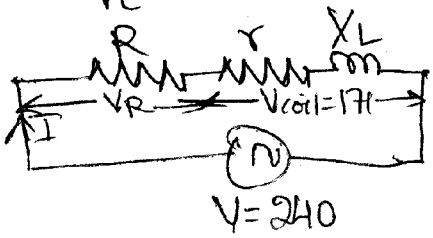
Phasor diagram for resonance is :-



Q19) $V = 240\angle 0°$

$I = 3\angle -37°$

$V_{Coil} = 171V$



$Z = \frac{V}{I} = \frac{240}{3} = 80\Omega$

$\cos\phi = \frac{R+r}{Z} \quad \therefore \cos(37) = \frac{R+r}{80}$

$\therefore R + r = 6.39 \quad \ldots (I)$

$Z_{coil} = \frac{V_{coil}}{I} = \frac{171}{3} = 57\Omega$

$\because Z_{coil} = \sqrt{r^2 + X_L^2}$

$\therefore r^2 + X_L^2 = 3249 \quad \ldots (II)$

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

$80 = \sqrt{(6.39)^2 + X_L^2} \quad \therefore X_L = 48.13\Omega$

Subs. in (II) $\therefore r = 30.54\Omega$

Subs in (I) $\therefore R = 33.36\Omega$

Q20) $I_L = 15A$

Total active power = 11,000W

Total apparent power = 15,000 VA

For star connection

$I_L = I_{ph} = 15A$

Active power $= \sqrt{3} V_L I_L \cos\phi$ --- (I)

Apparent power $= \sqrt{3} V_L I_L$ --- (II)

Divide by (I) by (II)

$\therefore \cos\phi = \frac{11,000}{15,000}$ $\therefore \phi = 42.83°$ (lag)

From (II)

$15,000 = \sqrt{3} V_L \times 15$ $\therefore V_L = 577.35 V$

$V_L = \sqrt{3} V_{ph}$ $\therefore V_{ph} = 333.33 V$

$Z_{ph} = \frac{V_{ph}}{I_{ph}} = 22.22 \Omega$

$\cos\phi = \frac{R}{Z_{ph}}$ $\therefore R = 16.3 \Omega$

$Z_{ph} = \sqrt{R^2 + X_L^2}$ $\therefore X_L = 15.1 \Omega$

For delta connection

$V_L = 577.35 V$

$V_L = V_{ph} = 577.35 V$

$Z_{ph} = 22.22 \Omega$

$I_{ph} = \frac{V_{ph}}{Z_{ph}} = 25.98 A$

$I_L = \sqrt{3} I_{ph}$ $\therefore I_L = 45A$

Active power $= \sqrt{3} V_L I_L \cos\phi$

$= \sqrt{3} \times 577.35 \times 45 \times \cos 42.83$

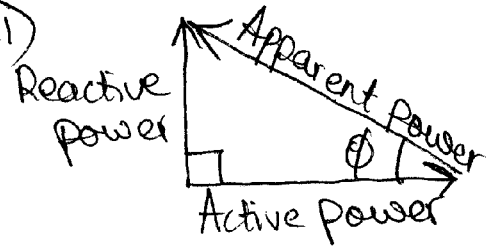
$= 33 kW$

Reactive power $= \sqrt{3} V_L I_L \sin\phi$

$= \sqrt{3} \times 577.35 \times 45 \times \sin 42.83$

$= 30.59 kVAR$

Q21)



Active power $= VI \cos\phi$

Units: Watts

Reactive power $= VI \sin\phi$

Units: Volt-Ampere-Reactive (VAR)

Apparent power $= VI$

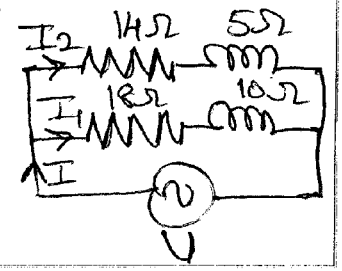
Units: Volt-Ampere (VA)

Q22) Let $Z_1 = 14 + j5$

$Z_2 = 18 + j10$

$V = 200V$

$f = 50Hz$



$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2}$ $\therefore Z = 7.94 + j3.47$

$Z = 8.66 \angle 23.59°$

(i) $Y_1 = \frac{1}{Z_1} = 0.063 - j0.023$

$Y_2 = \frac{1}{Z_2} = 0.043 - j0.024$

$Y = \frac{1}{Z} = 0.11 - j0.046$

(ii) $I_1 = \frac{V}{Z_1} = \frac{200}{14+j5} = 12.67 - j4.53 = 13.45 \angle -19.64°$

$I_2 = \frac{V}{Z_2} = \frac{200}{18+j10} = 8.49 - j4.72 = 9.71 \angle -29.05°$

$I = \frac{V}{Z} = \frac{200}{7.94+j3.47} = 21.15 - j9.24 = 23.08 \angle -23.61°$

(iii) $Z_1 = 14+j5 = 14.87 \angle 19.65°$

$Z_2 = 18+j10 = 20.59 \angle 29.05°$

$pf_1 = \cos\phi_1 = \cos 19.65 = 0.942$ (lag)

$Pf_2 = \cos\phi_2 = \cos 29.05 = 0.874$ (lag)

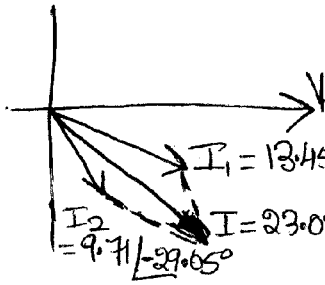
$P_1 = VI_1 \cos\phi_1 = 2.53$ kW

$P_2 = VI_2 \cos\phi_2 = 1.7$ kW

(iv) Total $pf = \cos\phi$

$= \cos 23.59$

$= 0.916$ (lag)



[DRAW TO SCALE COMPLETE PARALLELOGRAM]

Q23) $P_R = 1000W$

$P_r = 200W$

$V_R = 200V$

$V_{coil} = 300V$

(i) $P_R = V_R \times I \quad \therefore 1000 = 200 \times I \quad \therefore I = 5A$

$V_R = I R \quad \therefore 200 = 5 \times R \quad \therefore R = 40\Omega$

(ii) $I = 5A$

(iii) $P_r = I^2 r \quad \therefore 200 = 25 \times r \quad \therefore r = 8\Omega$

(iv) $Z_{coil} = \frac{V_{coil}}{I} = \frac{300}{5} = 60\Omega$

(v) $Z_{coil} = \sqrt{r^2 + X_L^2} \quad \therefore 60 = \sqrt{(8)^2 + X_L^2} \quad \therefore X_L = 59.46\Omega$

$Z = \sqrt{(R+r)^2 + X_L^2} = 76.42\Omega$

(vi) $V = I \cdot Z = 382.1\ V$

Q24) $Z_1 = 1 + j2$

$Z_2 = R_2$

$\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} \quad \therefore \frac{1}{Z} = \frac{1}{1+j2} + \frac{1}{R_2} = \frac{R_2 + 1 + j2}{R_2(1+j2)}$

$\therefore Z = \frac{R_2(1+j2)}{(1+R_2)+j2} \times \frac{(1+R_2)-j2}{(1+R_2)-j2}$

$= \frac{R_2 + j2 + R_2^2 + j2R_2 - j2R_2 + 4R_2}{(1+R_2)^2 + 4}$

$Z = \frac{R_2^2 + 5R_2 + j2}{(1+R_2)^2 + 4}$

$\because pf = 0.92 \therefore \cos\phi = 0.92 \therefore \phi = 23.07°$

$\tan\phi = \frac{2}{R_2^2 + 5R_2}$

$\therefore 0.426 = \frac{2}{R_2^2 + 5R_2} \quad \therefore 0.426R_2^2 + 2.13R_2 - 2 = 0$

$\therefore R_2 = 0.808\,\Omega$

825) Total active power = 10,000 W

$V_L = 440V$

$pf = 0.6$ (lead)

For Delta connection:-

$V_L = V_{ph} = 440V$

$Power = \sqrt{3} V_L I_L \cos\phi$

$10{,}000 = \sqrt{3} \times 440 \times I_L \times 0.6$

$I_L = 21.87\,A$

$I_L = \sqrt{3} I_{ph} \quad \therefore I_{ph} = 12.63\,A$

$Z_{ph} = \frac{V_{ph}}{I_{ph}} = 34.84\,A$

$\cos\phi = \frac{R}{Z_{ph}} \quad \therefore R = 20.9\,\Omega$

$Z_{ph} = \sqrt{R^2 + X_C^2} \quad \therefore X_C = 27.87\,\Omega$

Reactive power $= \sqrt{3} V_L I_L \sin\phi$

$= 13.33 \text{kVAR}$

826) $V(t) = 7.5t \quad 0 < t < 2$

$= 7.5(t-4) \quad 2 < t < 6$

$= 7.5(t-8) \quad 6 < t < 8$

$$V_{avg} = \frac{1}{T}\int_0^T v(t)\,dt$$

$$= \frac{1}{8}\left[\int_0^2 7.5t\,dt + \int_2^6 (-7.5)(t-4)\,dt + \int_6^8 7.5(t-8)\,dt\right]$$

$= 0$

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

$$= \sqrt{\frac{1}{8}\left[\int_0^2 (7.5t)^2\,dt + \int_2^6 [7.5(t-4)]^2\,dt + \int_6^8 [7.5(t-8)]^2\,dt\right]}$$

$= 8.66 \text{V}$

Q27) For bulbs connected in series, higher power rating of the bulb will glow brighter
∴ 100W, 230V bulb will glow much brighter.

Q28) Reference textbook Pg 261 (Q63)

Q29) $V = 200\sin 377t = V_m \sin \omega t$

$i = 8\sin\left(377t - \frac{\pi}{6}\right) = I_m \sin(\omega t + \phi)$

$V_m = 200V$, $I_m = 8A$, $\phi = -\pi/6$, $\omega = 377 rad/sec$

$V = \frac{V_m}{\sqrt{2}} = 141.4V$, $I = \frac{I_m}{\sqrt{2}} = 5.66A$, $\phi = 30°(lag)$

Active power $= VI\cos\phi = 693.1W$

Reactive power $= VI\sin\phi = 400.16 VAR$

Apparent power $= VI = 800.32 VA$

Q30) Solved Eq. (Q13) [R-L ckt.]

Q31) $P = 10,000W$

$I_L = 80A$ (lead)

$V_L = 1100V$

$f = 50Hz$

For Star Connection, $V_L = \sqrt{3} V_{ph}$

$\therefore V_{ph} = \frac{1100}{\sqrt{3}} = 635.1V$

$I_L = I_{ph} = 80A$

$Z_{ph} = \frac{V_{ph}}{I_{ph}} = 7.94\Omega$

$P = \sqrt{3} V_L I_L \cos\phi$

$10,000 = \sqrt{3} \times 1100 \times 80 \times \cos\phi$

$\therefore \cos\phi = 0.0656$ (lead)

$\because \cos\phi = \frac{R}{Z_{ph}} \quad \therefore R = 0.52\Omega$

$Z_{ph} = \sqrt{R^2 + X_C^2} \quad \therefore X_C = 7.92\Omega$

$X_C = \frac{1}{2\pi f C} \quad \therefore C = 401.9\mu F$

Q32) $X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi f}$

$X_L = 2\pi f L = 8\pi f$ where f is resonating freq.

Let $Z_1 = jX_L - jX_C = j\left(8\pi f - \frac{1}{2\pi f}\right)$

Let $Z_2 = -jX_C = \frac{-j}{2\pi f}$

$Z_p = \frac{Z_1 \times Z_2}{Z_1 + Z_2} = \frac{16\pi^2 f^2 - 1}{2\pi f j\left[16\pi^2 f^2 - 2\right]} = \frac{-j}{2\pi f}\left[\frac{16\pi^2 f^2 - 1}{16\pi^2 f^2 - 2}\right]$

$Z = 10 + Z_2 = 10 - \frac{j}{2\pi f}\left[\frac{16\pi^2 f^2 - 1}{16\pi^2 f^2 - 2}\right]$

Since circuit is at resonance
∴ It is resistive, hence its imaginary part will be 0

$$\therefore \frac{-j}{2\pi f}\left[\frac{16\pi^2 f^2 - 1}{16\pi^2 f^2 - 2}\right] = 0$$

$$\therefore 16\pi^2 f^2 = 1 \quad \therefore f = 0.0796\ Hz$$

Q33) $Z_1 = 3+j4,\ Z_2 = 4-j3,\ Z_3 = 4.057+j5.51$

(i) $Y_p = Y_1 + Y_1 \quad \left(\because \frac{1}{Z_p} = \frac{1}{Z_1} + \frac{1}{Z_2}\right)$

$\therefore Y_p = 0.28 - j0.04$

$Z_p = 3.5 + j0.5$

$Z = Z_p + Z_3 = 8.07 + j6.01 = 10.06 \angle 36.68°$

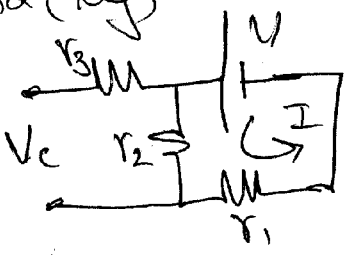
(ii) $I = \frac{V}{Z} = 15.94 - j11.87 = 19.88 \angle -36.68°$

(iii) $pf = \cos\phi = \cos(36.68°) = 0.82\ (lag)$

Q34) $I = \frac{V}{r_2 + r_1}$

$V_{r_2} = I \times r_2 = \frac{V r_2}{r_1 + r_2}$

$V_c = V_{r_2} = \frac{V \times r_2}{r_1 + r_2}$



Q35) $V = 5\cos\omega t = 5\sin(\omega t + 90°) = V_m \sin(\omega t + \phi)$

$i = I \sin\omega t = I_m \sin\omega t$

$V = \frac{V_m}{\sqrt{2}} \angle\phi = \frac{5}{\sqrt{2}} \angle 90°$

$I = \frac{I_m}{\sqrt{2}} \angle\theta° = \frac{1}{\sqrt{2}} \angle 0°$

$\phi = 90°$

$P = VI\cos\phi = \frac{5}{\sqrt{2}} \times \frac{1}{\sqrt{2}} \times \cos 90° = 0\,W$

Q36) $V = \sqrt{V_R^2 + V_L^2} = \sqrt{(16)^2 + (12)^2} = 20V$

$Z = \frac{V}{I} = \frac{20}{5} = 4\Omega$

Q37) $v = V_m \sin\theta \quad , \alpha < \theta < \pi$

$= 0$, elsewhere

$V_{avg} = \frac{1}{T}\int_0^T v\,d\theta = \frac{1}{2\pi}\int_0^{2\pi} v\,d\theta$

$= \frac{V_m}{2\pi}\int_\alpha^\pi \sin\theta\,d\theta = \frac{V_m}{2\pi}\left[-\cos\theta\right]_\alpha^\pi$

$= \frac{V_m}{2\pi}\left[1 + \cos\alpha\right]$

$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2 d\theta} = \sqrt{\frac{1}{2\pi}\int_\alpha^\pi \sin^2\theta\,d\theta}$

$= \sqrt{\frac{1}{2\pi}\int_\alpha^\pi \left(\frac{1-\cos 2\theta}{2}\right) d\theta}$

$$V_{rms} = \sqrt{\frac{1}{2\pi}\left[\frac{\theta}{2} - \frac{\sin 2\theta}{4}\right]_{\alpha}^{\pi}}$$

$$V_{rms} = \sqrt{\frac{1}{2\pi}\left[\frac{\pi}{2} - \frac{\alpha}{2} + \frac{\sin 2\alpha}{4}\right]}$$

Q38) Solved Eg. (Q1) [Series Resonance]

Q39) Reference bk Pg 247 (Q49)

Q42) i) For unity pf (UPF)

$pf = \cos\phi = 1 \quad \therefore \phi = 0^\circ$

$\because \tan\phi = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right)$

$\tan 0 = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right) \quad \therefore \omega_1 = \omega_2$

ii) Zero pf

$\therefore pf = \cos\phi = 0 \quad \therefore \phi = 90^\circ$

$\tan\phi = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right)$

$\tan 90^\circ = \infty = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right)$

$\therefore \omega_1 + \omega_2 = 0 \quad \therefore \omega_1 = -\omega_2$

iii) pf 0.5 (lag) $\therefore \cos\phi = 0.5 \quad \therefore \phi = 60^\circ$

For lagging pf, $\tan\phi = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right) \quad \therefore \sqrt{3} = \sqrt{3}\left(\frac{\omega_1 - \omega_2}{\omega_1 + \omega_2}\right)$

$\therefore \omega_1 - \omega_2 = \omega_1 + \omega_2 \quad \therefore \omega_2 = 0$