11.5

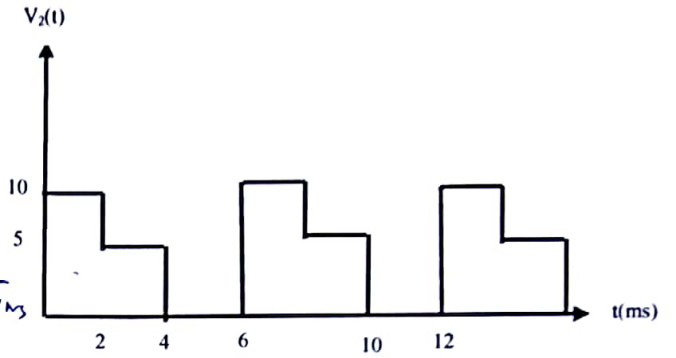
University of Jordan	EE212 - Electric Circuits II	First Exam	Sunday, 19/3/2017
Department of Electrical Engineering	Second Semester 2016-2017	Time: 1 Hour	15:00 - 16:00 pm

Questions 1 (5 points)

a) Find the RMS value for the following voltage waveforms:
   1) $v_1(t) = 5\sin(wt) + 8\cos(wt)$ V
   2) The signal shown in the figure $v_2(t)$.

b) Find the RMS value of a source V where $V = V_1 + V_2$.

c) Find the real power absorbed by a load Z = 4+j5 Ω that is connected in parallel with a voltage source $V = V_1 + V_2$.



a) 1) $\sqrt{\frac{5^2}{2} + \frac{8^2}{2}} = 6.67\ V_{rms}$

2) $V_{rms} = \sqrt{\frac{1}{T}\int_0^T V(t)\,dt} = \sqrt{\frac{1}{6}\int_0^2 10^2 + \int_2^4 5^2 + \int_4^6 0^2}$

$= \sqrt{\frac{1}{6}\,100t\Big|_0^2 + 25t\Big|_2^4 + 0}$

$= \sqrt{\frac{1}{6}(200 + 50)} = 6.45\ V_{rms}$

b) $(6.67)^2 + (6.45)^2$

$= \sqrt{6.67^2 + 6.45^2}$

$= 9.278$

c) $V = I R$

$9.278 = I\,(4+j5)$

$I = 2.319$

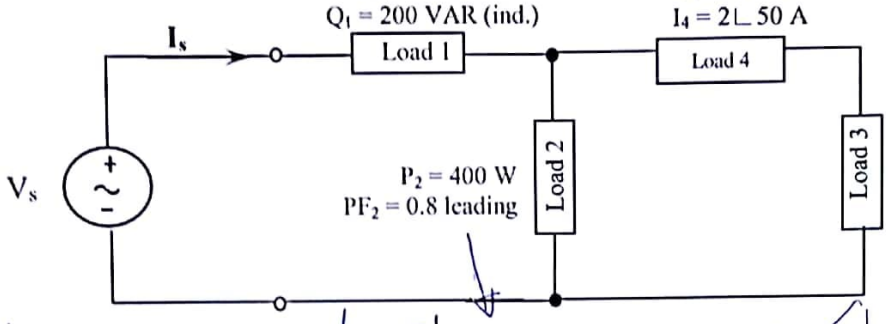
$P = V I = 21.52$

V_{1RMS}	V_{2RMS}	$V_{RMS(eff)}$	P
6.67 V	6.45 V	9.278 V	21.52 W

Questions 2 (5 points)

The circuit shown below consists of four loads in a series-parallel connection, with each of the loads defined as indicated. Find:

a) The overall complex power supplied by the source, S_s.
b) The overall source power factor, PF_s.
c) The source phasor current, I_s.
d) The phase and magnitude of the current that flows in load 2.



a) $S_1 = 100 + j200$

$S_2 = 400 - j299.5$

$S_3 = 54.54 - j65$

$S_4 = 61.2 + j51$

$S_{total} = 615.74 - j113.5$

$\cos^{-1}(0.8) = 36.8$

$\sin 36.8 = \frac{3}{5}$

$|S| = \frac{P}{\cos(36.8)} = \frac{400}{0.8} = 500$

$\therefore Q = |S| \sin 36.2 = 299.5$

b) $pf = \frac{P}{|S|} = \frac{615.74}{626.11} = 0.983$

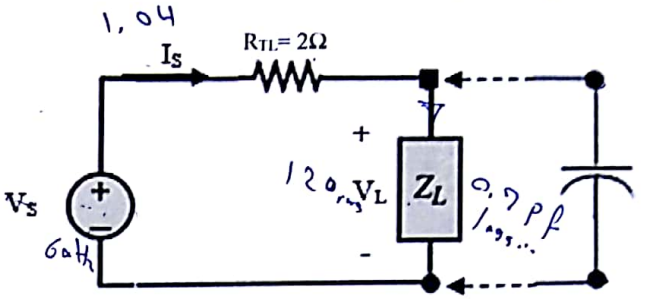
c) $S = \frac{I_s^2}{R} \cos\theta \Rightarrow$

S_S	PF_S	I_S	I_2
615.74 -j113.5	0.983		

Questions 3 (5 marks)

The circuit shown depicts a load with 0.8 lagging PF that absorbs 100 W, the load voltage V_L is 120 V and the source frequency is 60 Hz. It is required to correct the power factor of the load by adding a capacitor of 10μF, Find:

a) the PF of the source before connecting the capacitor.
b) the new load PF after connecting the capacitor.
c) the new source current after connecting the capacitor.
d) the losses in the line before and after the connecting the capacitor.



3.5

$V_L = Z_L I_S$

$120 = z_L I_S$

$P = V_{rms} I_{rms} \cos\theta$

$P = I_L V_L \cos\theta$

$100 = I_L\ 120\ 0.8$

$I_L = 1.04$

$Z_L = \frac{V}{I} = \frac{120\angle 0}{1.041}$

$= 115.24\angle 0$

$V_S = I_S(2 + 115.24)$

$1.041 \times (117.24)$

$V_S = I_S 2 + 120$

$= 122.08$

$\tan^{-1}\left(\frac{54.2}{100}\right) = 28.4$

$\cos(28.4) = 0.879$

$Q = I_S V_S \sin\theta$

$54.2 = I_S 120\ (0.47) = 0.94$

$\tan^{-1}(0.2) = \frac{Q}{100}$

$+V$

$C = \frac{Q_C}{\omega V^2}$

$10 = \frac{Q_C}{2\pi 60\ 120^2}$

$Q_C = 54.2$

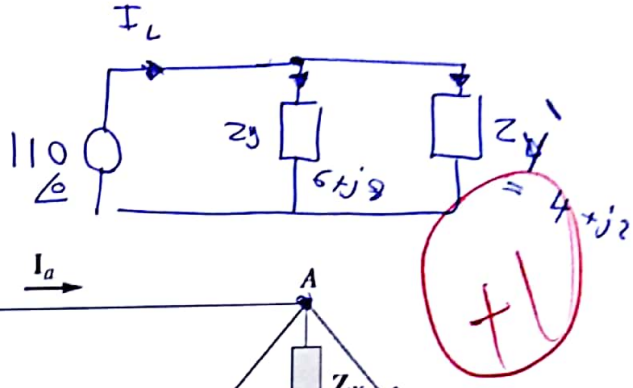
75

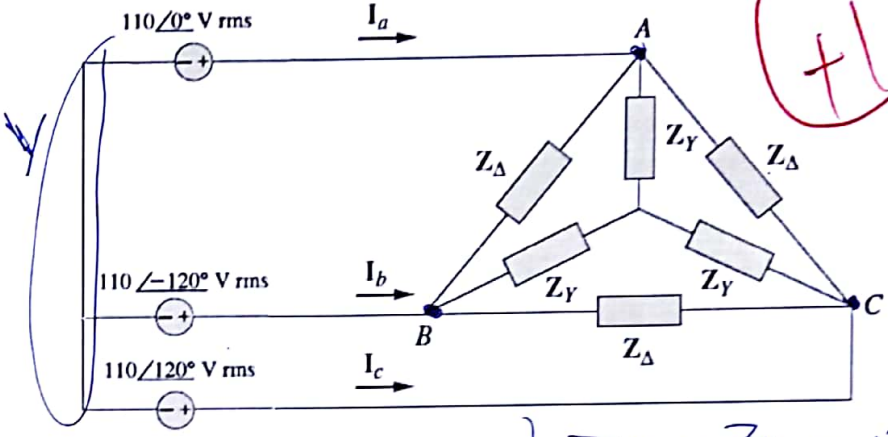
$PF_{before(source)}$	$PF_{after(Load)}$	$I_{S(new)}$	$P_{losses(before)}$	$P_{losses(after)}$
0.8	0.879	1.04 + 0.94	75 VAR	54.2 VAR

Questions 4 (5 points)

The circuit drawn shows a balanced 3 phase Y source of 110 V phase to neutral voltage suppling a balanced Y connected load of $Z_Y = 6+j8$ connected in parallel with Delta load with $Z_\Delta = 12 + j6$. Find:

a) the phase current in phase B of the Y load.
b) the phase current in phase CA in the Delta load.
c) the total current in line A supplied by the source.
d) the total power supplied to the load.
e) the combined load power factor.





$$Z_{eq} = \frac{Z_y * Z_y'}{Z_y + Z_y'}$$

$$= 2.6 + j1.8$$

$$I_a = \frac{110\angle 0}{2.6 + j1.2}$$

$$= 34.7\angle -34$$

$$I_b = 34.7\angle -154$$

$$Z_y = \frac{Z_\Delta}{3} = \frac{12+j6}{3} = 4+j2$$

$$\Rightarrow I_{B\,y_{load}} = \frac{(34.4\angle 154 * 4 + j2)}{10 + j10}$$

$$I_B = 10.8\angle -172$$

$$I_{AC} = \frac{110\angle 120}{12 + j6} = 8.1\angle 93.4 = 110\angle 120 * \sqrt{3}\angle 30 = 14.2\angle 224$$

I_B	I_{CA}	$I_{Line(total)}$	$P_{(total)}$	$PF_{(load)}$
~~24.7 ∠154~~	14.2 ∠224	0		

10.2 ∠−172