5/20

Name: [redacted] **Serial** [redacted]

Questions 1 (4 marks)

Figure Q1 shows the voltage $v(t)$ applied to a load and its absorbed instantaneous power $p(t)$. If the load composed of resistive R and reactive X elements in series, find the following:

a.	the voltage peak V_m,	V_m = 20 V
b.	the frequency, f, of the voltage waveform,	f = 0.083 kHz
c.	the average power P drawn by the load,	P = 150 W
d.	the current peak I_m,	I_m = 15 A
e.	the phase shift θ between $v(t)$ and $i(t)$,	θ = 90°
f.	the load power factor pf,	pf = 1
g.	the instantaneous power $p(t)$.	$p(t)$ = 150 + J Φ

Fig. Q1

$P = \frac{1}{2} V_m I_m \cos\theta$

$= \frac{1}{2}(20)(15)\cos$

$= 150$ W

$P_{max} = \frac{1}{2} V_m I_m$

$150 = \frac{1}{2}\, 20\, I_m$

$I_m = 15$ A

1

Questions 2 (3 marks)

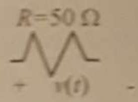


Fig. Q2

In Fig. Q2, a voltage waveform $v(t)$ that appears across a 50-Ω resistor is given by:

$v(t) = 5 + 15\sin(100\pi t) + 5\sin(300\pi t) + 3\sin(500\pi t) + 2\sin(700\pi t)$ V. Find

a.	the average voltage of the voltage waveform	$V_{dc} =$ 5 V
b.	the rms voltage of the voltage waveform	$V_{rms} =$
c.	the average power absorbed by the 50-Ω resistor	$P =$ 0.25 W

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

$\omega = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega}$

~~$V_{rms}^2 = \frac{15}{0.02}\int_0^{0.02} \sin^2(100\pi t)\,dt + 5\int \sin(300\pi t)\,dt$~~

~~$\omega = 2\pi f$~~

$f = \frac{\omega}{2\pi}$

$P = \frac{1}{2} V_m I_m \cos\theta$

$= \frac{1}{2}\, 5\,(0.1)(\cos 0) = 0.25$ W

$v = IR$

$I = \frac{v}{R}$

$I_m = \frac{5}{50} = 0.1$ A

Power Unit

Questions 3 (5 marks)

For the circuit of Fig. Q3, find

a.	the average power dissipated in the 5 Ω and 8 Ω resistances,	$P_{5\Omega}$ = 55.963 w $P_{8\Omega}$ = −0.766w
b.	the complex power supplied by the source.	S_{source} = 55.96 + J 37.92 VAR

$P = \frac{1}{2} V_m I_m \cos\theta$

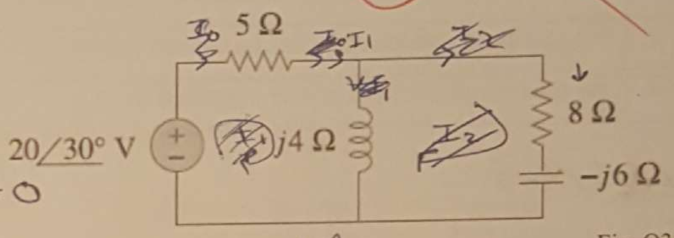
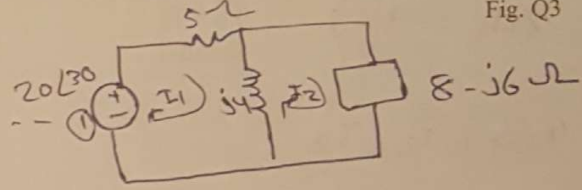


Fig. Q3

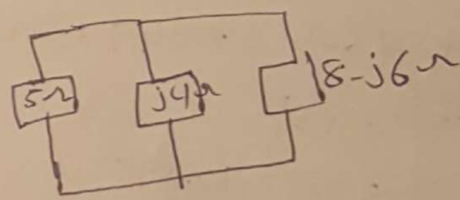
$-20\angle 30 + 5I_1 + 4j(I_1 - I_2) = 0$

$j4(I_2 - I_1) + (8 - j6)I_2 = 0$

$-20\angle 30 + (5+4j)I_1 - 4jI_2 = 0$ --- ①

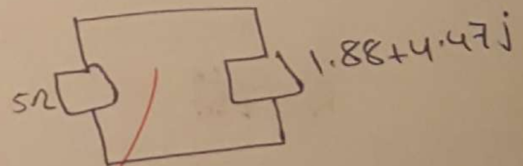


$(8-2j)I_2 - 4jI_1 = 0$ --- ②



$I_1 + I_2 = 6.76\angle -4.12$ A --- ③

$I_1 = 6.76\angle -4.12 - I_2$

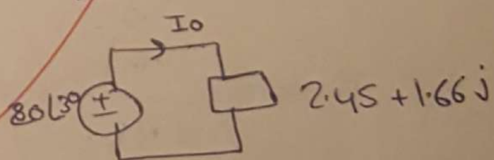


$(8-2j)I_2 - 4j(6.76\angle -4.12 - I_2) = 0$

$(8-2j)I_2 - 27.04\angle 85.88 - 4jI_2 = 0$

$I_2 = 2.704\angle 122.75$ A

$I_1 = 8.66\angle -18.59$ A



$I_o = 6.76\angle -4.12$ A

$P_{5\Omega} = \frac{1}{2} V_m I_m \cos\theta$

$= \frac{1}{2}\, 20\,(6.76)\cos(30 + 4.12)$

$P_{5\Omega} = 55.963$ W

$P_{8\Omega} = \frac{1}{2} V_m I_m \cos\theta$

$= \frac{1}{2}(11.82)(2.704)(-0.047)$

$= -0.766$ W

−4

$S = P + JQ$

$P = \frac{1}{2} V_m I_m \cos\theta_z$

$= \frac{1}{2}\, 20\,(6.76)(0.83)$

$= 55.96$ W

$Q = \frac{1}{2} V_m I_m \sin\theta_z$

$= \frac{1}{2}\, 20\,(6.76)(\sin\theta_z)$

$= 37.92$ VAR

$S = 55.96 + J\,37.92$ VAR

Questions 4 (4 marks)

The variable resistor R in the circuit of Fig. Q4 is adjusted until it absorbs the maximum average power. Reduce the circuit into its Thevenin equivalent as seen from the variable resistance side, and find,

a.	the Thevenin voltage	V_{Th} = 8.381 ∠12.095° V
b.	the Thevenin equivalent impedance	Z_{Th} = 9 - j Ω
c.	the resistance which absorbs maximum power,	R = 9 Ω
d.	the maximum average power absorbed by R.	P_{max} = 1.385 W

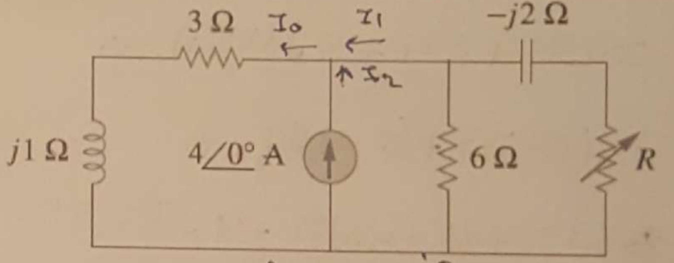


Fig. Q4

$Z_{th} = 9 - j$

$4\angle 0 + I_1 = I_o$

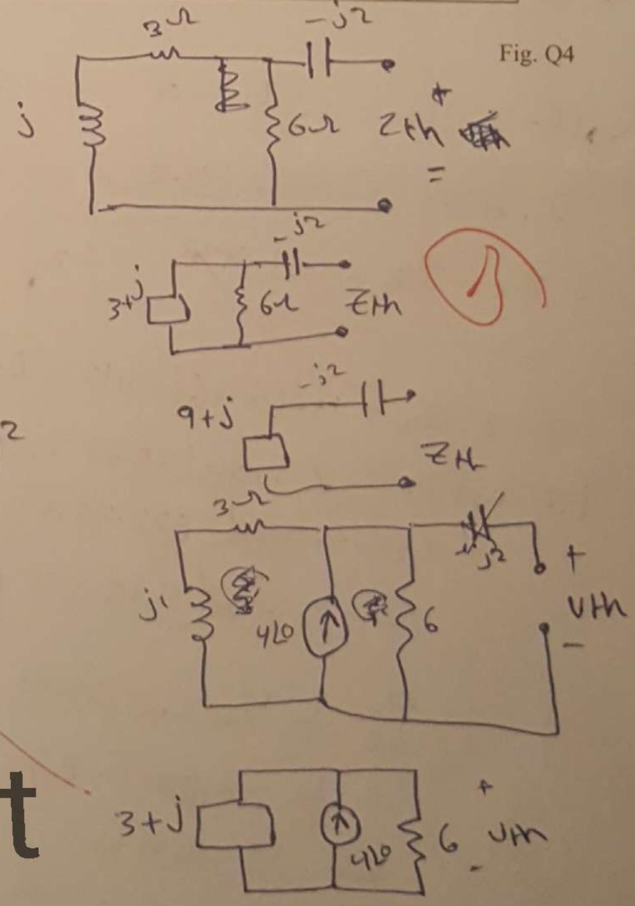
$3 + j \,//\, 6\Omega = 2.049 + 0.439j$

$V_{th} = Z(I)$

$= 8.381 \angle 12.095$ V

$P_{max} = \frac{|V_{th}|^2}{8R_L} = \frac{(8.381)^2}{8(6.34)}$

$= 1.385$ W

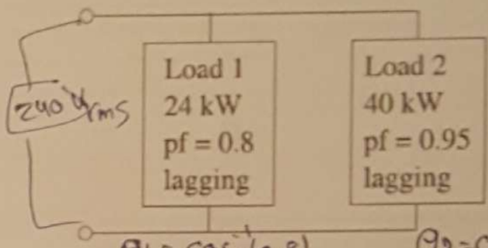


Power Unit

Questions 5 (4 marks)

A 240-Vrms, 50-Hz source supplies two loads connected in parallel, as shown in Fig. Q5. find

a.	the overall complex power supplied by the source,	S_{source} = 64000 + 14943.55j VA
b.	the power factor of the parallel combination.	pf = 0.974 lagging
c.	the size of the capacitor in kVAR when connected in parallel that will raise the power factor to 0.95 lagging.	Q_C = 26.88 VAR
c.	the value of the capacitance in μF.	C = 1.485 μF



$V_{rms} = 240$

$\omega = 100\pi$

$Q_C = P(\tan\theta_1 - \tan\theta_2)$

$= 64(0.749 - 0.329)$

$= 26.88$ VAR

$pf = \frac{P}{S}$

$pf = \cos\left(\tan^{-1}\frac{Q}{P}\right)$

$= 0.974$

$C = \frac{Q_C}{\omega V_{rms}^2}$

$C = 1.485$ MF

$\theta_1 = \cos^{-1}(0.8)$ $\quad \theta_2 = \cos^{-1}(0.95)$

$\theta_1 = 36.869$ $\quad \theta_2 = 18.19°$

$Q_1 = S \sin\theta$

$S_1 = 3$ kVA

$Q_1 = 3k \sin(36.86)$

$= 1799.59$ VAR

$S_2 = \frac{40k}{0.95}$

$S_2 = 42105$

$Q_2 = 13143.96$ VAR

$pf = \frac{P}{S}$

$Q_{total} = 14943.55$ VAR

$P = 64$

$S = 64k + 14943.55$ kVA

$|S| = 65721.46$

3

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