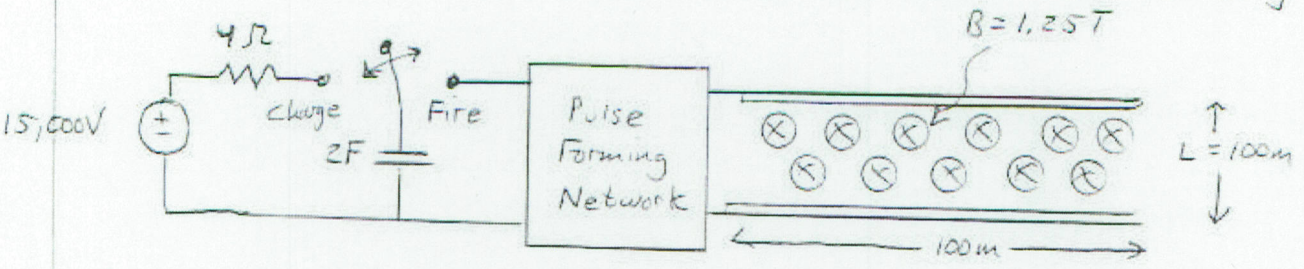
EE331 Review Exam #2

Problem 1 Given the linear motor aircraft launcher from lecture but this time assume that we have the capacitive energy storage system "up front" and that the pulse-forming network and rails are 50% efficient. The plane mass is 50,000kg.



(a) How long does it take for the capacitor bank to "fully" charge? How much energy is stored?

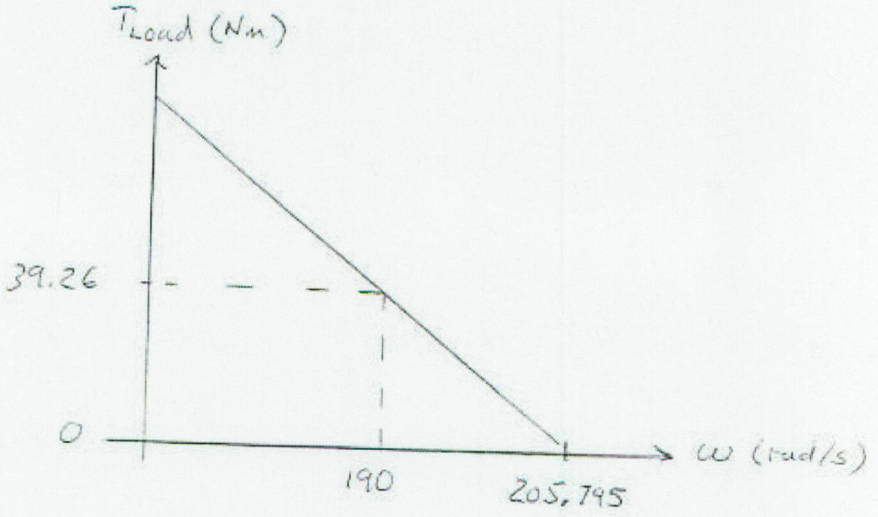
(b) How much energy is available for launching and what is the terminal velocity?

(c) How much time does it take to launch?

(d) What is the rail current?

T F The back EMF is 15,000V upon takeoff

Problem 2 The load torque on a permanent magnet DC motor is measured at different speeds so we assemble the following curve. The data is taken with $V_a = 120V$. The vendor reports that the nominal armature resistance is $0.1353\,\Omega$



(a) Assuming T_{Loss} is constant, Find K_v and T_{Loss}

(b) Find the motor efficiency when it operates at $\omega = 190$ rad/s

T F The armature of a rotating PM DC machine is stationary

The brushes of a PM DC machine connect to

(a) The armature (b) The commutator

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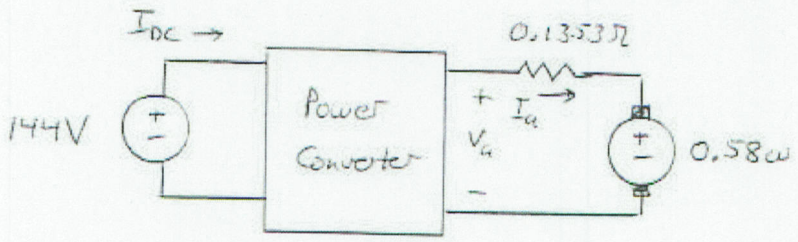
Problem 3. Given the same motor from prob 2 is controlled with a power converter where the duty cycle is set for 0.6. The converter is 96% efficient and is supplied from a 144V battery bank. The load torque applied to the motor is governed by $T_{Load} = 0.001\omega^2$

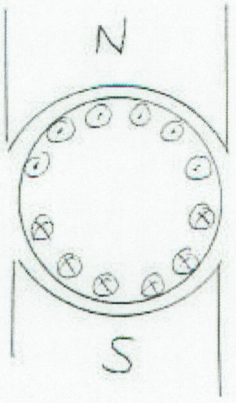


(a) Find the average armature voltage

(b) Find the average armature current and rotor speed

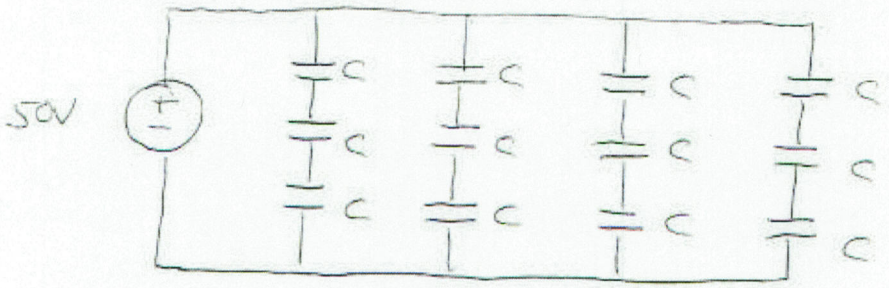
(c) Find the average current supplied by the battery

Q. What direction will the armature turn if the current distribution is for motor operation?

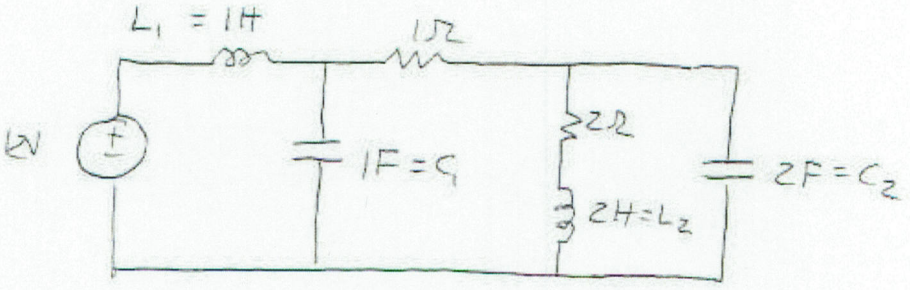


(d) IF we attach external resistance (no converter) to control speed, what value is required to achieve $\omega = 140 rad/s$?

Problem 4. What value of capacitance C is required to store 1000 J of energy?

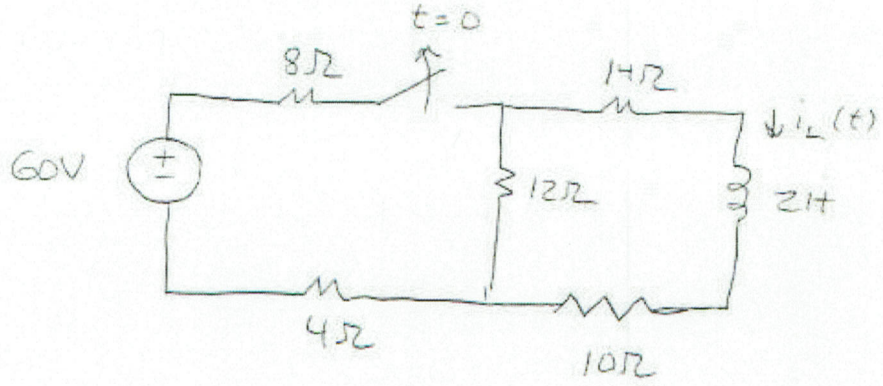


Problem 5 Determine the steady-state energy stored in each component



The instantaneous change of inductor (voltage, current, power) will cause a problem.

Problem 6. Given the following circuit, Find $i_L(t)$ for $t>0$

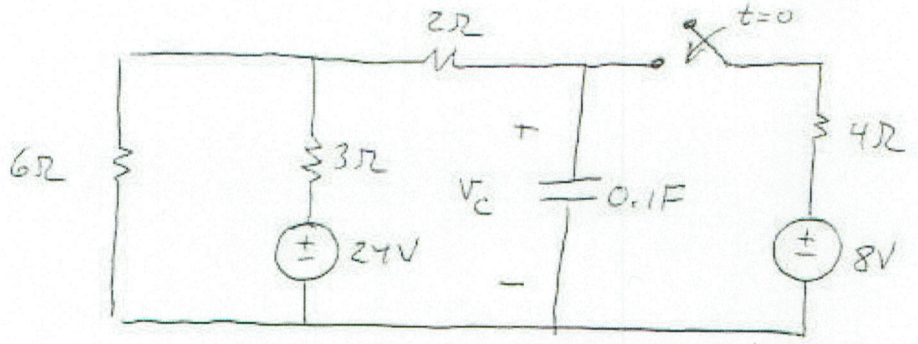


(b) At what time does the energy drop to 6.25% of its original value?

(c) When is the energy "fully" depleted?

(d) If we reclosed the switch, how long for the current to charge up to $\frac{1}{2}$ A?

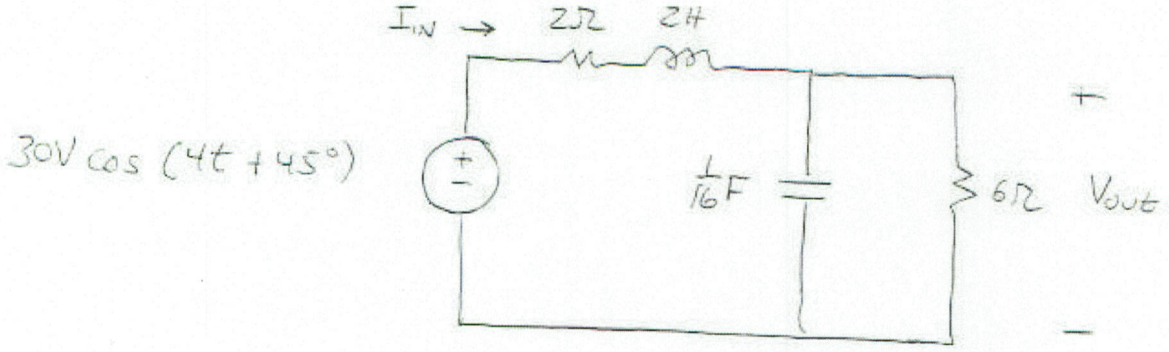
Problem 7 Given the following circuit



Find the expression for $v_c(t)$ for $t \geq 0$

(Assume steady-state conditions exist at t<0)

Problem 8 Given the following time-domain circuit



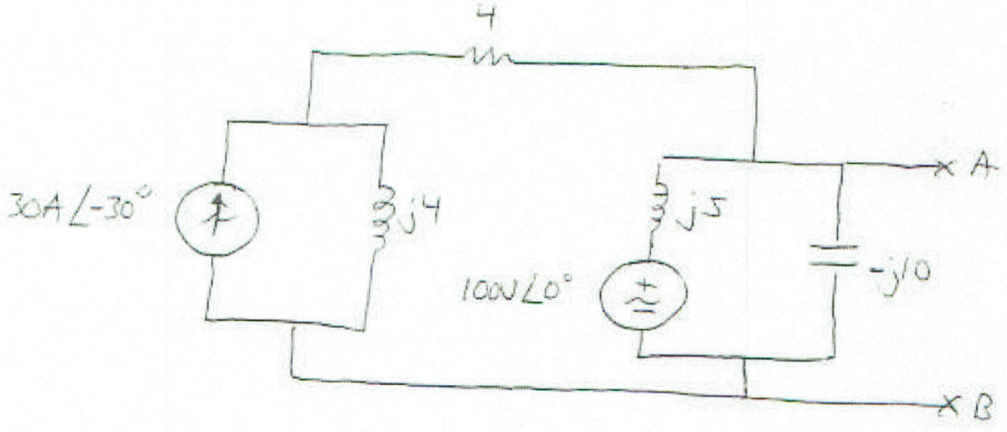
(a) Find the steady-state expressions for V_{OUT} and I_{IN}

(These should be time-domain sinusoids)

(b) Sketch the phasors $\tilde{V}_{in}$ and $\tilde{I}_{in}$ and state who leads whom and by what angle

(c) Find the circuit input impedance From your values

Problem 9 Given the following frequency-domain circuit

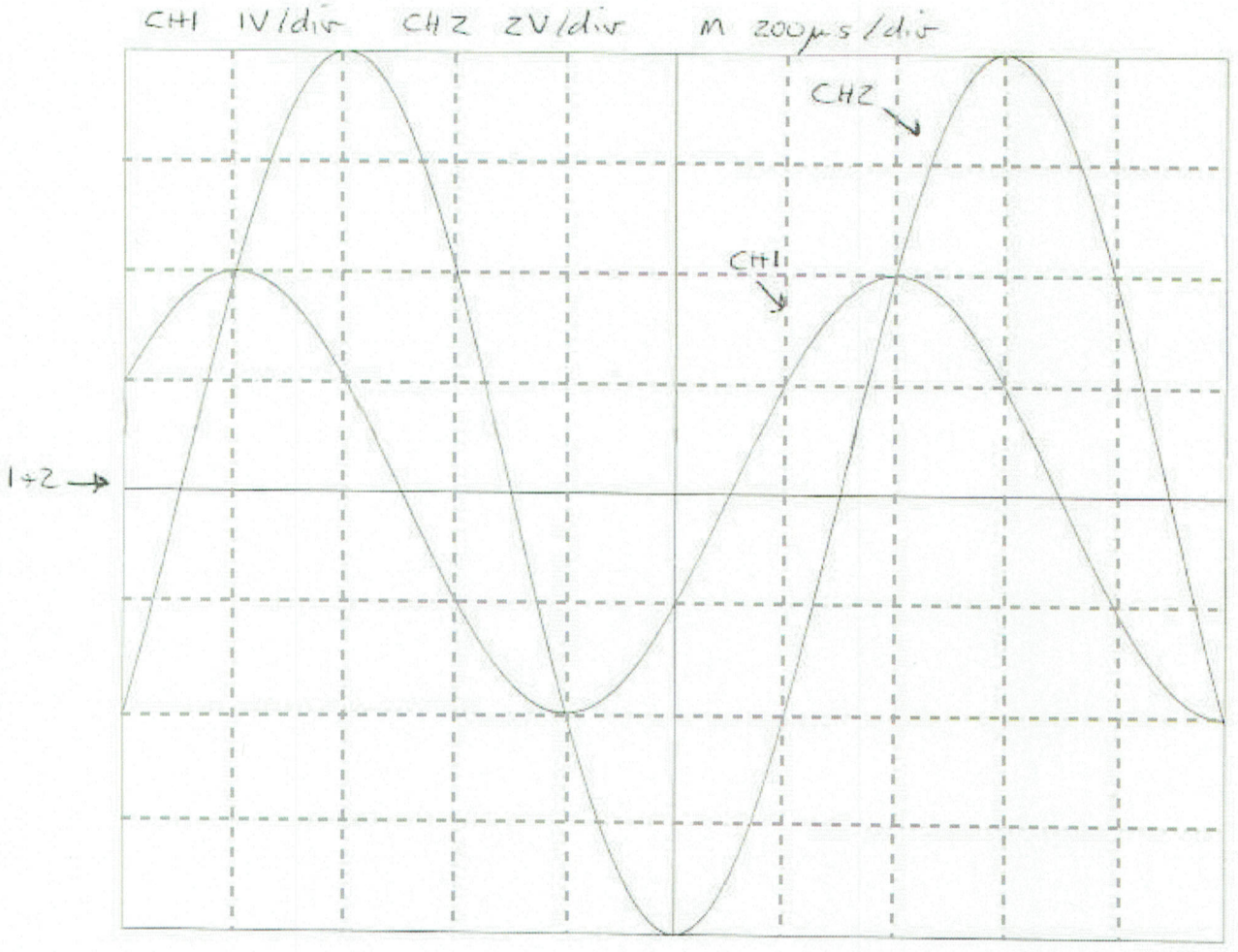


Find the Thevenin Equivalent "seen" from terminals A and B

If the source frequencies are 20rad/s, what capacitor do we need to attach to the Thevenin so that the voltage source and its current are in phase?

Problem 10 Given the Following scope image

a. Find the Frequency (in Hz)

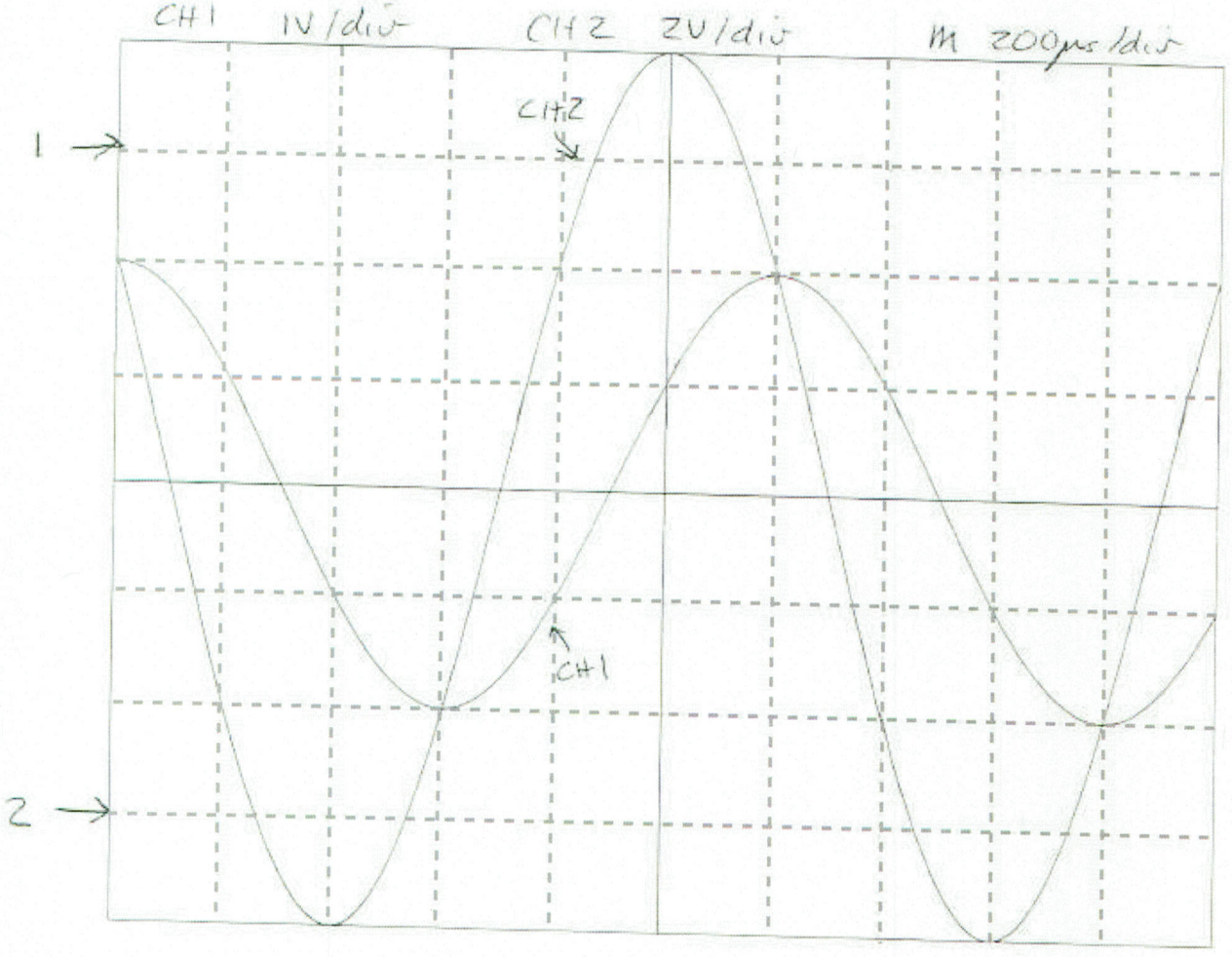


b. Who leads whom and by how much

c. RMS value of CH2 signal

Problem 11. Given the following scope image

a. Determine the DC offset

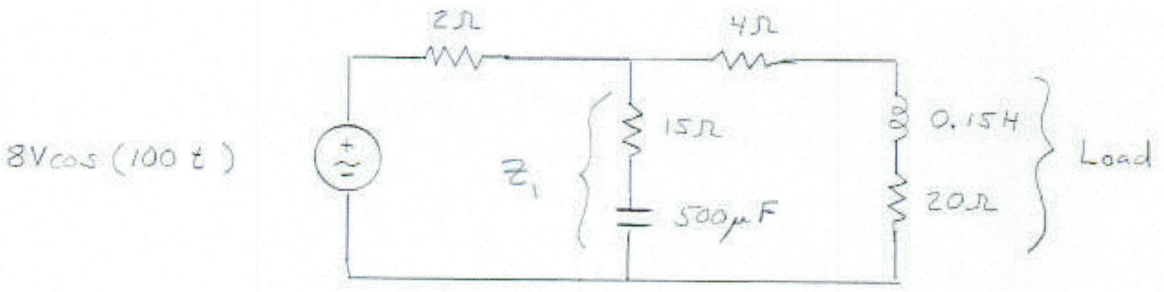


b. If we use the DMM VAC measure on CH1, what does it read?

Topics

- Single-Phase AC Power
- Power Factor Correction

ex. 1 Given the following circuit, Find the real and reactive power consumed by the load



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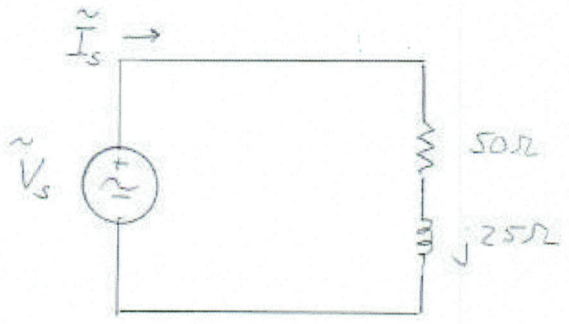
ex. 2 The Follow R-L load consumes 800W



Determine $\tilde{V}_s$ and $\tilde{I}_s$ and the source apparent power

ex. 3 For the previous circuit, if the source frequency is 60Hz, Find the capacitor required to power factor correct to unity.

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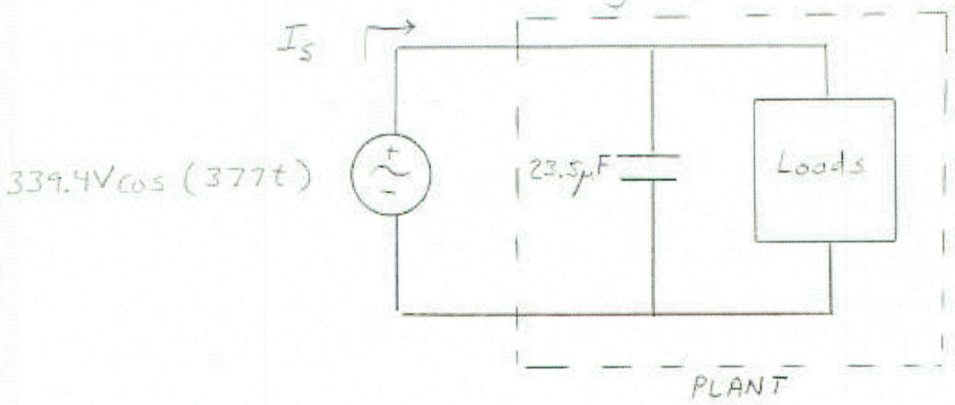
ex. 4 Given the following system, if $I_s = 3.929A\cos(377t - 25.84°)$



Find the power factor and real & reactive power of the load