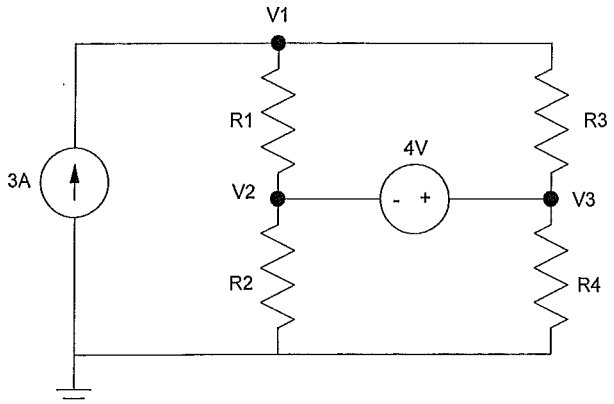
# ECE 331 Test 1: Name _____

February 5, 2014. Magnetic Circuits

1) KVN. Write 3 equations to solve for the 3 unknown voltages



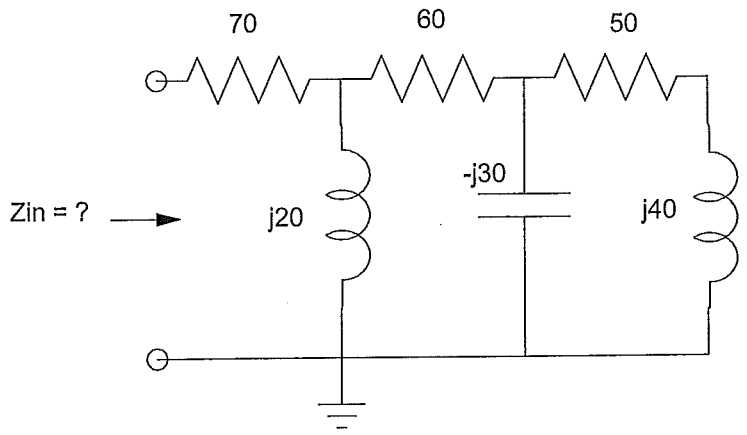

$$-3 + \frac{V_1 - V_2}{R_1} + \frac{V_1 - V_3}{R_3} = 0$$

$$V_3 - V_2 = 4$$

$$\frac{V_2 - V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3 - V_1}{R_3} + \frac{V_3}{R_4} = 0$$

Supernode

2) Determine the impedance, Zin:




| Zin = | $75 + j20.8$ |
|---|---|

$= 50 + j40$ 4

$(8+j40) \| (-j30) = 17.30 - j33.46$ 4

$+60 = 77.3 - j33.4$ 4

$\| j20 = 5.02 + j20.8$ 4

$+70 = 75 + j20.8$ 4

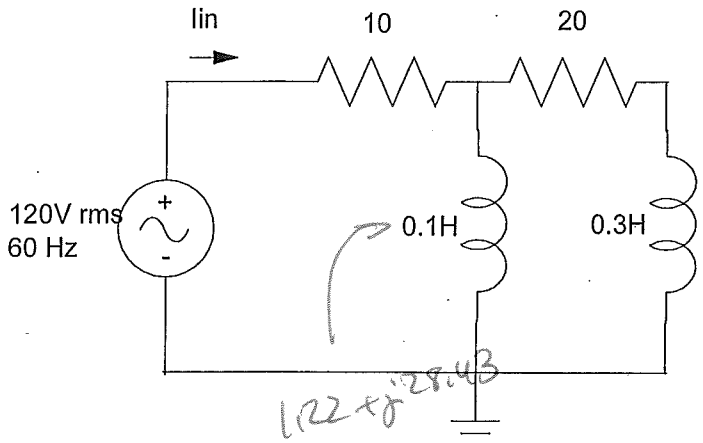
3) Assume the input to the following circuit is a 120V rms sine wave at 60Hz (377 rad/sec).

3a) Determine the phasor impedances for the two inductors,

| 0.1H | 0.3H |
|---|---|
| $j37.7$ | $j113.1$ |

3b) Determine the current, In, in phasor notation

| Iin (rms) |
|---|
| $3.92 \angle -68°$ |




$Z = 11.22 + j28.43$ (10)

$I = 1.44 - j3.65$

$= 3.92 \angle -68°$ (5)

$-1.18$ radians

4) Determine the complex impedance as well as a series and parallel RL circuit to model a load with the following characteristics:

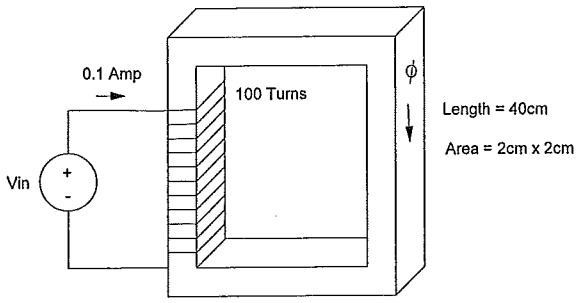
- VL = 120V rms
- IL = 6A rms
- Power 100 Watts

| | |
|---|---|
| Impedance: $Z_L$ | $20 \angle 82.01°$ 1.43rad |
| Series Resistance: Rs | 2.78 |
| Series Reactance: jXs | $j19.8$ |
| Parallel Resistance: Rp | 143 |
| Parallel Reactance: jXp: | $j\,20.19$ |

$pf = \frac{100}{120.6} = .13888$

5) An inductor is composed of an iron core with

- A cross sectional area of 2cm x 2cm.
- A total length around the inductor of 40cm
- A relative permittivity of 5000
- A saturation of B = 2 Teslas




Note:

| | |
|---|---|
| $\phi = \frac{F}{R}$ | Flux (Webers) |
| $F = NI$ | MMF (amp-turns) |
| $R = \frac{length}{\mu_r \mu_0 Area}$ | Reluctance $(\mu_0 = 4\pi \cdot 10^{-7})$ |
| $B = \frac{\phi}{Area}$ | Flux Density (Webers) Teslas |

5a) Determine the reluctance of the iron core, the flux ($\phi$) in Webers, and the flux density, B, in Teslas.

| | |
|---|---|
| Reluctance (R) | $= \frac{.4m}{(5000)(4\pi \cdot 10^{-7})(.02)(.02)} = 159,154$ |
| Flux (Webers) | 62.8 μWb |
| Flux Density (Teslas) | .157 Teslas |

5b) If the frequency of the input is increased, will the flux density (B) go up or down? Why?

flux goes down

the impedance $j\omega L = jX$ goes up

the current $= \frac{V}{jX}$ goes down

flux is proportional to current