EE 204.3

(Instructors: D. Lynch, A. Ortlepp)

Midterm Examination

Friday, Oct 25, 2013

8:30 – 9:20AM / 11:30AM – 12:20PM

Time Allowed: 50 minutes

Materials allowed: One 8½" X 14" formula sheet,

Calculator

Language Translation Dictionary (paper)

Instructions:

- **Answer all questions *in pen* in the space provided; show relevant work if possible (use page backs for rough work if necessary).**
- **Pay attention to signs and units!**
- **Any references to AC voltages are RMS and 60 Hz unless otherwise specified or obvious.**
- **State your assumptions; show relevant work. Use the space provided for your answer; use the back of previous page if required. (Calculate a number as an answer; don't leave it as an expression unless asked to do so. Also, don't forget units!).**
- **Put your name and student number on the cover page; put *only* your student number on all remaining pages.**

p1	p2	p3	p4	p5	Total
3	6	9	4	3	/25

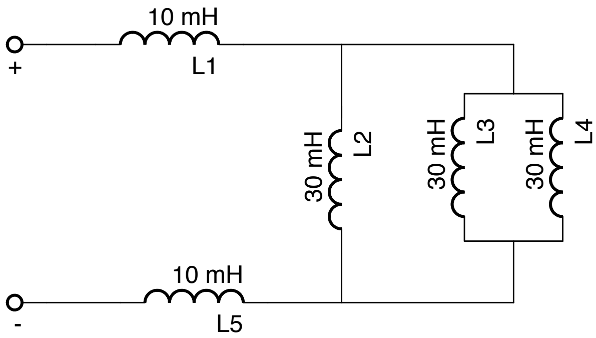
Name:____

Student Number:______________________________________

Section Attended *(for return purposes)*: **8:30 (2C02)** ☐ **11:30 (1B71)** ☐

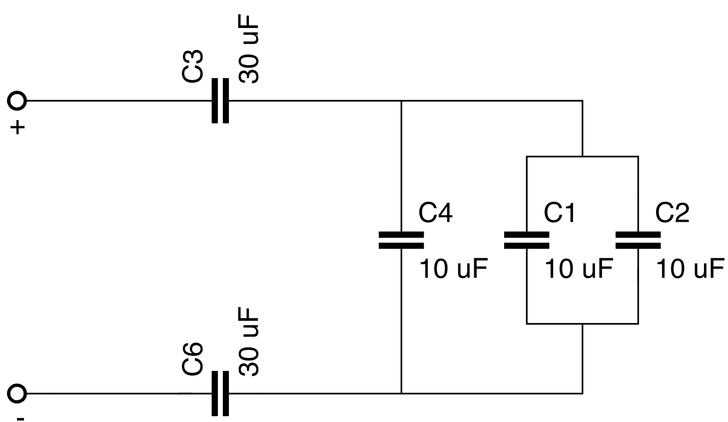
Please respect the rules of the University regarding conduct for examinations, and keep the contents confidential until all students have completed the examination. Thank you for your cooperation.

1) Find the value of the total inductance of the arrangement shown in the figure below.
[1]



L_T= ______________________***30mH***___

2) Find the value of the total capacitance of the arrangement shown in the figure below.
[1]



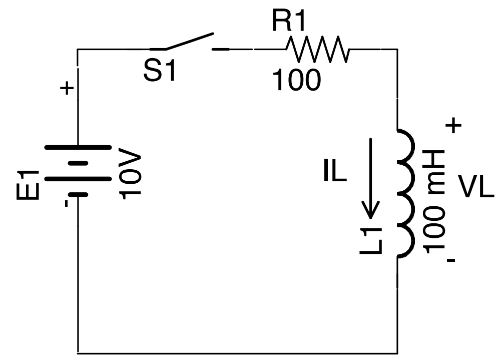
C_T= ______________________***10µF***___

3) What is the voltage across a 100mH inductor if the expression for the current is:
i(t) = (0.5 + 3t)A?
[1]

V_L= ______________________***.3V***___

$v_L = L\ di/dt = .1H(3) = .3V$

4) What is the expression for the current through the inductor after the switch is closed?



[3]

________________ $i(t)=100\left(1-e^{-t/1ms}\right)mA$ ______

$\tau = L/R_{Th}(=100\Omega) = .1H/100\Omega = 1ms$; τ=L/R = .1H/100=1ms;

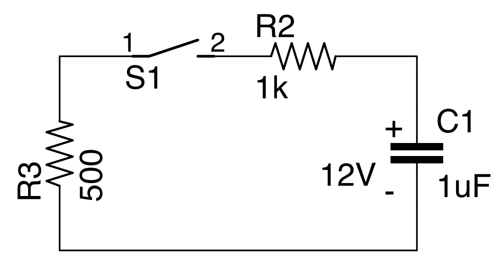
$I_i = 0\left(i(t=0^-=0\right)\ I_f = \frac{10V}{100\Omega} = 100mA$

$i(t) = I_f - (I_f - I_i)e^{-t/\tau} A = 100\left(1-e^{-t/1ms}\right)mA$

current is positive, in the direction shown by the arrow.

5) The capacitor in the circuit below has an initial charge of 12V as shown. What is the expression for the current for the period after the switch is closed?

[3]



________________ $i(t) = -8e^{-t/1.5ms}mA$ ______

$\tau = R_{Th}C = (1k\Omega + 500\Omega)(1\mu F) = 1.5ms$

$I_i = \frac{12V}{1.5k\Omega} = -8mA \quad I_f = 0$

$i(t) = I_f - (I_f - I_i)e^{-t/\tau} A = -8\left(e^{-t/1.5ms}\right)mA$

We generally considered current *into* the capacitor during the charging phase as positive, so this should be *negative*. -1 if not

6) Determine the following phasor voltages and currents (give answers in the same form as the question):

[3]

a) $120\angle 0^0 V + 120\angle 90^0 V =$ ______________________________ $170\angle 45^0$V

b) $60\angle 135^0 V - 30\angle -45^0 V =$ ______________________________ $90\angle 135^0$V

if we ADDED them the result would be 60, but to subtract, we reverse the vector.

c) $(20 + j30)V + (-30 + j10)V =$ ______________________________ $(-10 + j40)V$

7) Determine the following complex impedances, Z :

[3]

a) *For a circuit that draws* $2\angle -45^0 A$ *from a* $120\angle 0^0 V$ *source:* ______________ $60\angle 45^0\Omega$

b) *A 330Ω resistor in series with a capacitive reactance of 200Ω* ________ (330-j200)Ω

Rectangular form was expected, but either is correct

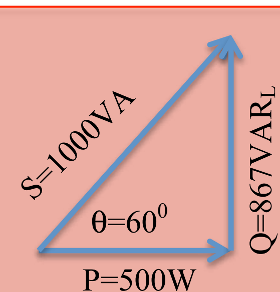
c) *An ideal 100mH inductor connected across a 60Hz source* ____________ $37.7\angle 90^0\Omega$

Polar form was expected, but either is correct

8) Draw and label the Power Triangle if the Apparent Power, $S = 1000\angle 60^0 VA$

[1]

Need the drawing and all 4 labels!



Power Triangle

9) Determine the Reactive Power consumed by a fully loaded 10Hp motor which has an efficiency of 90% and a Power Factor of 0.65 lagging. (Note: 1Hp – 746W)

[2]

Q______________________________9691VAR_____

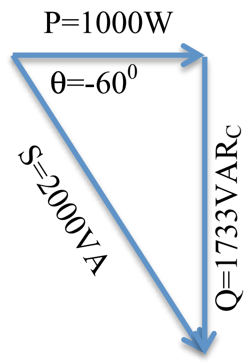
$$Q = \frac{10\,Hp\left(746\,{}^{W}\!/_{Hp}\right)}{.9}\tan\left(\cos^{-1}(.65)\right) = 9691\,VAR_{Inductive}$$

as long as it's shown as positive, the "Inductive" is not necessary in this case

10) For the load represented by the Power Triangle shown below, determine the value and type (C or L) of reactor that will improve the power factor to 0.9 leading if it is to be connected across a 600VAC 60Hz source.

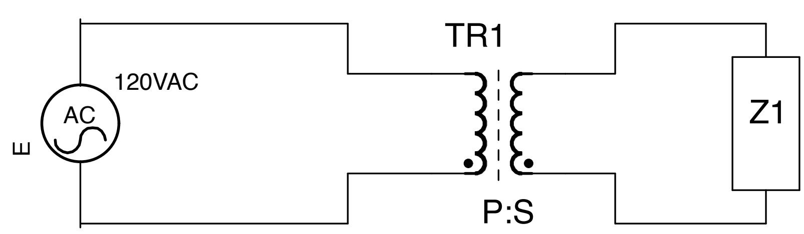
[2]

________________________________765mH_____



$$Q_{New} = (1000W)\tan\left(\cos^{-1}(.9)\right) = 484VAR_{Capacitive}$$
$$\Delta Q = Q_{New} - Q_{Old} = (-484VAR) - (-1733VAR) = +1249VAR_{(Ind)}$$
$$X_L = \frac{|V|^2}{\Delta Q} = \frac{600^2}{1249} = 288.2\Omega$$
$$L = \frac{288.2\Omega}{377} = 764.5mH$$

11) Consider the single transformer circuit shown in the figure below.



a) If the current drawn from the *120VAC (60Hz)* source is $3\angle 26^0 A$, what is the apparent power, *S*, delivered to the load impedance, Z_1?

[1]

$$S = VI^* = (120\angle 0V)(3\angle 26A)^* = 360\angle -26^0 VA$$

$$Z = \frac{V}{I} = \frac{120\angle 0V}{3\angle 26A} = 40\angle -26^0\Omega$$

b) If the phasor voltage and current of the source are as given in a) and Z_1 is $10\angle\text{-}26^0\Omega$, determine the P:S turns ratio? (P:S = Primary to Secondary)

[1]

$$\frac{Z_S}{Z_1} = \left(\frac{P}{S}\right)^2$$

$$\frac{P}{S} = \sqrt{\frac{40}{10}} = 2$$

P:S = 2:1

12) Consider the multi-transformer circuit shown in the figure below. Each of the coils in each of the transformers is 50 turns. $Z_L = 1920\angle 45^0 \Omega$.

a) Determine the voltage required at the load (i.e. across Z_L) which will result in an Apparent Power, S, of $480\angle 45^0 VA$ being delivered to the load.

[2]

V: ______________________________960V______

The angle is arbitrary, so any or none will do.

$$S = VI^*$$

$$Z = \frac{V}{I}$$

$$|S| = |Z||I|^2$$

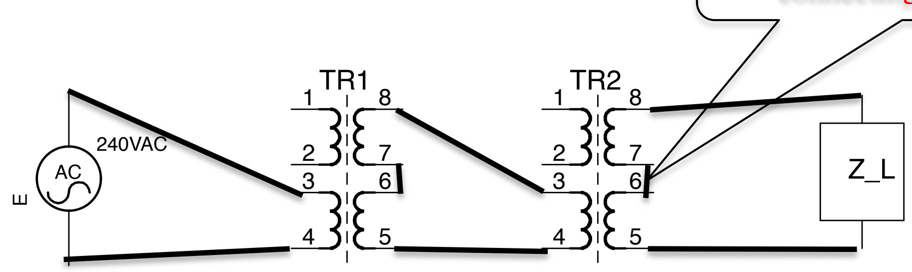
$$|I| = \sqrt{\frac{S}{Z}} = .5A$$

$$|V| = \frac{480VA}{.5A} = 960V$$

b) Draw the interconnections between the source, E, transformers, *TR1 and TR2*, and load impedance, Z_L which will result in an Apparent Power, S, of $480\angle 45^0 VA$ being delivered to the load. (i.e. Interconnect E to the primary(s) of TR1, the secondary(s) of TR1 to the primary(s) of TR2, secondary(s) of TR2 to the load. You may not need *all* the windings!.)

[1]

Don't forget these bridges when connecting two windings.



many options to get the 960V out; we need two 1:2 step up configurations.