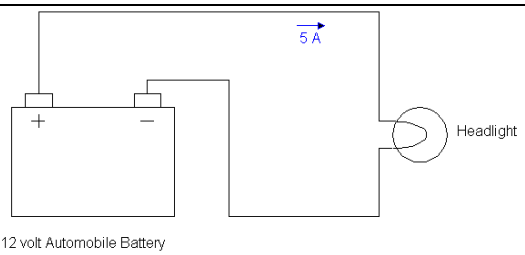
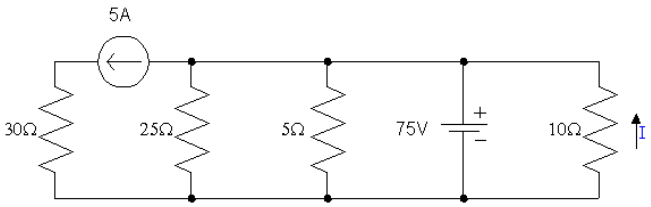
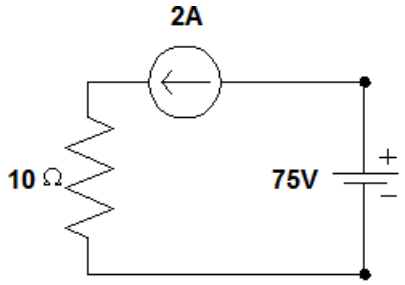
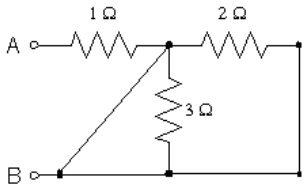
ENGR 12 **Final Exam** **NAME**_____

1) How much energy is delivered to the headlight if it is left on overnight for 8 hours? Express your answer in kW-hours.	
P = 5*12 = 60W E = P*t = 60*8 = 480 W-hours = .48 kW-h	
2) Find I in the circuit on the right: I = - 75/10 = -7.5A	
3) How much total current is provided by the 75 V source for the circuit shown in Prob 2?	KCL: I = 5A + 3A + 15A + 7.5A = 30.5A
4) What is the Voltage change across the 5A current source for the circuit in Prob 2? Reference + to the head of the current arrow, and – to the tail.	KVL: -150 + V_{5A} + 75 = 0, therefore V_{5A} = 75 Volts
5) For the circuit on the right, what is the power associated with the current source and the voltage source and indicate whether each is absorbing or releasing power. P_{2A} = 2*55 = 110 W (absorbing) P_{40V} = -2*75 = -150W (releasing)	
6) What is the power associated with the resistor for the circuit in Prob 5? P_{R10} = 2^2*10 = 40 Watts P_{R10} = 2^2*10 = 40 Watts	

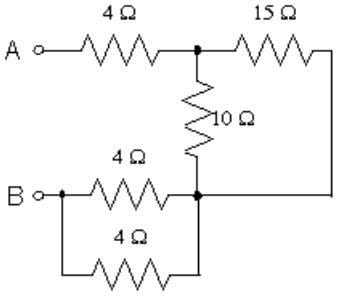
7) What is the equivalent resistance from A to B?

Req = 1 + 0||2||3 = 1 Ohm



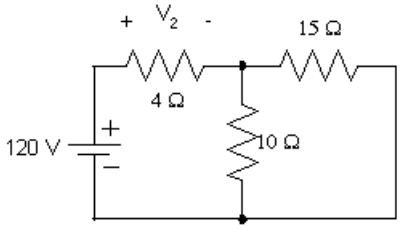
8) What is the equivalent resistance from A to B?

Req = 4 + 10||15 + 4||4
= 4 + 150/25 + 2
= 4 + 6 + 2
= 12 Ohm



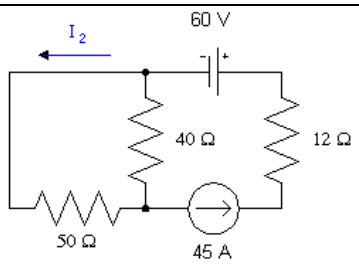
9) Use the Voltage Divider Formula to find V_2

$V_2 = 120 * 4 / (15||10 + 4) = 120*4/10 = 48V$



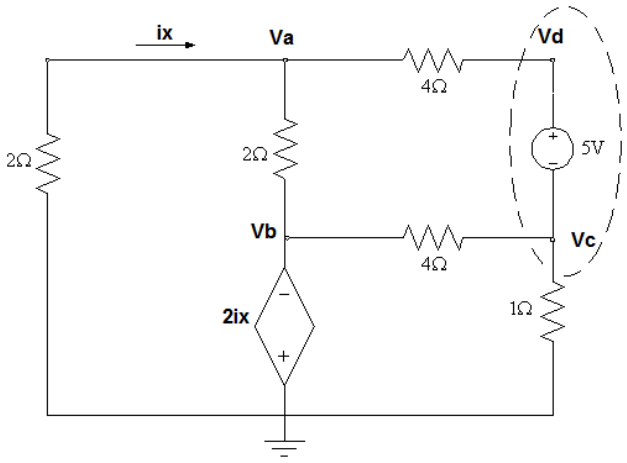
10) Use the Current Divider Formula to find I_2

$I_2 = 45 * 40 / (50 + 40) = 45 * 40/90 = 20A$



11) Write the Node Voltage Equation for the Va node in terms of Va, Vd, and Vb (ignore the supernode and ix for now):

$$\frac{Va}{2} + \frac{Va - Vb}{2} + \frac{Va - Vd}{4} = 0$$



12) Express Vd in terms of Vc in the circuit for prob 11, in other words,

Vd = Vc + 5

13) Write the Node Voltage Equation for the Supernode shown in the above circuit:

$$\frac{Vd - Va}{4} + \frac{Vc - Vb}{4} + \frac{Vc}{1} = 0$$

14) Express ix in terms of Va for the circuit in #11

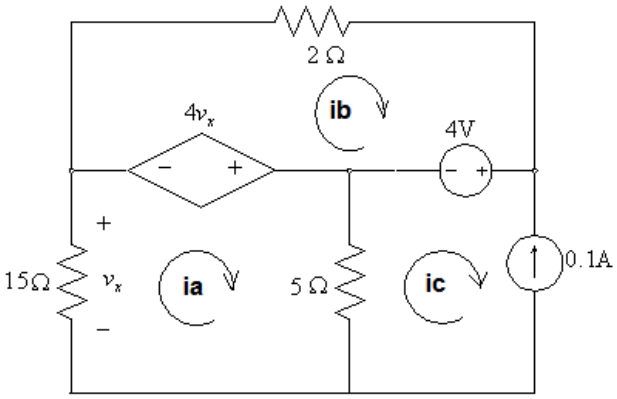
ix = -Va / 2

15) Substitute your answer for 14) for ix in the dependent source to arrive at an expression for Vb in terms of Va:

Vb = -2ix = -2 * - Va/2 = Va

16) For the Mesh Current circuit on the right, express Vs in terms of ia:

Vs = - 15 ia



17) Express the mesh current for Mesh A without using Vs (substitute answer for #16):

15 ia - 4*(-15ia) + 5(ia-ic) = 0

80 ia - 5 ic = 0

18) Express the mesh current for Mesh B without using Vs (substitute your answer for #16)

4*(-15ia) + 2ib + 4 = 0

60 ia + 2 ib = -4

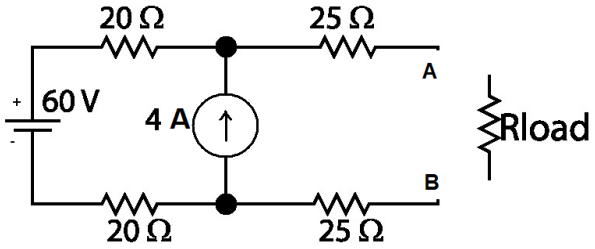
19) By inspection, what is the current ic?

ic = -.1 A

20) What is the Thevenin Voltage of the Circuit shown:

(no current flows thru 25 Ohm resistors)

Vth = V4A = 60 + 4*(20+20) = 220V



21) What is the Thevenin Resistance of the circuit from Problem 20?

(4A source is like open cct, 60V src like short)

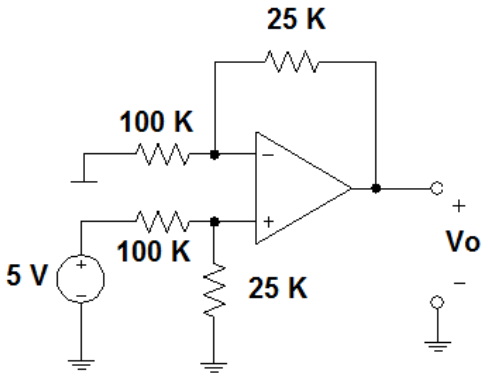
Rth = 20 + 25 + 20 + 25 = 90 Ohms

22) What value of Rload will result in maximum power transferred to the load resistor?

Rload = Rth = 90 Ohms

23) What is the value of V+ at the Op-Amp input?

V+ = 5V * 25/(100 + 25) = 1 V



24) Assuming the Op-amp is in its linear range, what is the value of V- ?

V- = 1V

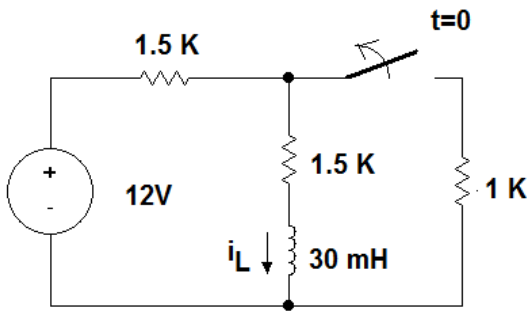
25) Still assuming linearity, what is the output voltage Vo?

V- / 100 + (V- - Vo)/25 = 0
V- + 4(V- - Vo) = 0
Vo = 5V- / 4 = 1.25 V

26) For the circuit at right, prior to t=0 the switch has been closed a long time. What is the resistance seen by the 12V supply before the switch opens?

Prior to t=0, Req = 1.5 + 1.5||1 = 1.5 + 1.5/2.5

Req = 2.1 K-Ohm



27) What is the current through the inductor before the switch opens?

IL(0-) = (12/ 2.1) * 1/(1 + 1.5) = 2.287 mA

28) What is the final value of current through the inductor after the switch has been open a long time?

$I_L(f)$ = 12V / 3k = 4 mA

29) What is the time constant for the R-L circuit after the switch opens?

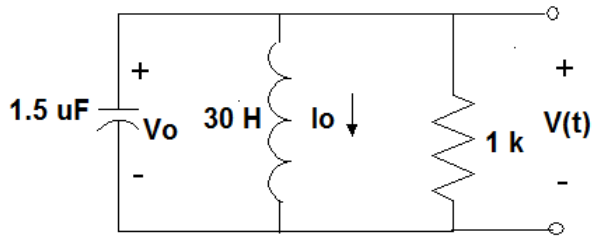
Tau = L/ R = 30 mH / 3 kOhm = 10 microsec

30) Write the equation for inductor current as a function of time

$I(t) = i(f) + (i(0) - i(f))e^{-t/tau} =$
$= 4 + (2.287 - 4)\, e^{-t/tau} = 4 - 1.73\, e^{-10\text{^}5t}$

31) For the parallel RLC circuit shown, find alpha, w_o, s1, and s2

alpha = 1/(2RC) = $1/(2*1000*1.5x10^{-6}) = 333$
w_o = sqrt(1/LC) = $sqrt(1/(2*1.5x10^{-6})) = 149$
s1 = -333 + $sqrt(333^2 - 149^2) = -35$
s2 = -333 – $sqrt(333^2 - 149^2) = -631$



32) Is the circuit over, under or critically damped?

overdamped

33) If Vo = 10V and Io = 2 mA, calculate v, and dv/dt at $t=0^+$

$v(0^+) = 10$

dv/dt at $t=0^+$ = ic/C = (-2 – (10V/1K) / C

= -12mA/1.5uF = -8000 V/s

34) Suppose v(t) = 220cos(50t - 67°) volts

a) What is the radian frequency, w in Rad/sec?

w = 50 R/s

b) What is the frequency in Hz?

f = w/2pi = 50/6.28 = 7.96 Hz

c) What is the period, T?

T = 1/f = .1256 sec

d) What is the rms value of v(t)?

Vrms = 220/sqrt(2) = 155.6

35) Complex Math

a) Convert 50 – 45j to polar form

Mag = sqrt($50^2 + 45^2$) = 67.2

Phi = atan(-45/50) = -41.9 degrees

b) Convert 30/ 25 to rectangular form

Ans= 27.1 + 12.6j

c) Find (25/-60) / (40 + 10j)

in phasor form:

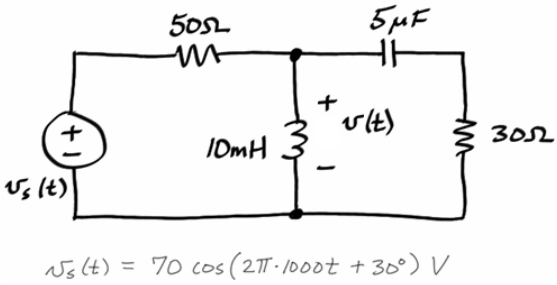
Ans = .606 / -74

36) For the AC circuit to the right, find

Zc and Z_L w = 2pi*1000 = 6283

Zc = - j/(wC) = -31.8j

ZL = jwL = 62.8j



$v_s(t) = 70\cos(2\pi \cdot 1000t + 30°)$ V

37) Find the equivalent impedance of the parallel branches for the circuit in problem 36:

Zp = ZL || (30 + Zc) = 62.8j*(30-31.8j)/(30+31j)

= (1997+1884j)/(30+31j) = 63.6/-2.89

38) Find an expression for the phasor voltage V across the 10 mH inductor:

V = Vs Zp / (50 + Zp) =

= 70/30 *63.6/-2.89 / 113/-1.6 =39.3/28.7

39) Convert your answer to 38) into the time domain:

v(t) = 39.3 cos(2 pi 1000t + 28.7)

40) If the current into a load is I = 40 /35 and the Voltage is V = 10 /-20,

Determine the:

a) Average power P: = ½ *40*10*cos(-20-35)

= 200cos(-55) = 115 W

b) Reactive power Q: = 200sin(-55) = -164 var

	c) Complex Power S: = 115 -164j VA
41) A 3 phase Y-source has phase voltages: Van = 120/50, Vbn = 120/170, Vcn = 120/-40 Find the line voltages Vab, Vbc, and Vca Vab = 207/20 Vbc = 207/140 Vca = 207/-70	

42) Write the mesh equation for mesh 2 in the transformer circuit on the right:
 	
`j6 I2 + j3I1 −j4I2 + 10I2 = 0`
or,
`(j3)I1 + (10 + j2) I2 = 0`