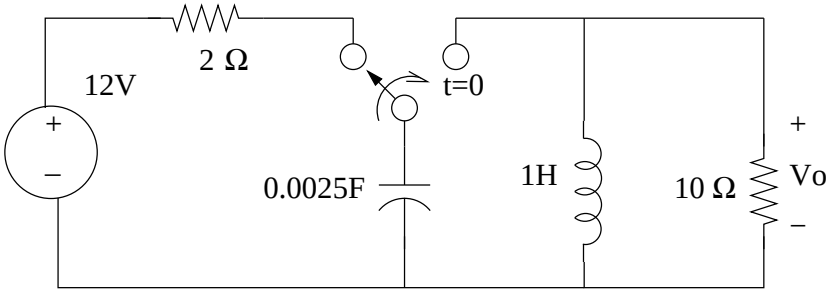
Electrical Engineering Ph.D. Written Qualifying Exam
Spring 2009

Choose six (6) of the eight (8) questions you wish to be graded by circling the question numbers.

1. Find $v_o(t)$ for $t > 0$ in the network below.



2. Solve the following equation:

$$(\frac{d^2}{dt^2} + 5\frac{d}{dt} + 6)y(t) = (\frac{d}{dt} + 1)f(t)$$

if the initial conditions are

$$y(0-) = 2,\ \frac{dy}{dt}(0-) = 1,$$

where $f(t) = e^{-4t}u(t)$, and $u(t)$ is the unit step function.

3. A given finite state machine has an input, w and an output z. During four consecutive clock pulses, a sequence of four values of the w signal is applied.

   (a) Drive a state table for the FSM that produces z=1 when it detects that either the sequence w: 0010 or w: 1110 has been applied; otherwise z=0. After four clock pulses, the machine has to be again in the reset state, ready for the net sequence.

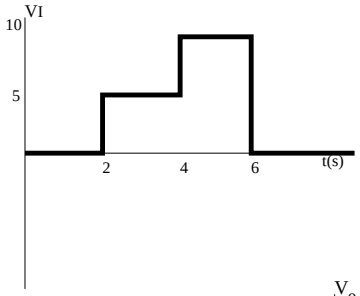
   (b) Minimize the number of states needed.

4. A 25HP induction motor operates from a 480V, 60Hz single phase ac supply. When delivering rated power (25HP) the p.f. is known to be 0.68 lagging and the efficiency is 94%. (Hint 1HP = 746W)

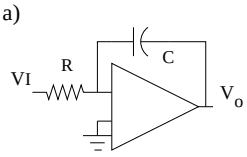
   (a) Draw the power triangle the motor and determine the current the source is supplying.

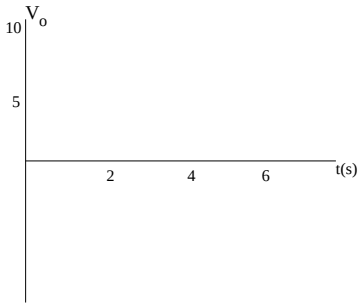
   (b) It is desired to improve the power factor for the system of above problem to 0.95 lagging using a static capacitor bank. Determine the value of capacitance that is required to do so and calculate the new supply current.

5. The input voltage waveform V_I shown below is applied to each of three op-amp circuits also shown below. For each circuit, derive an expression for the output voltage $V_O(t)$ and then plot it as accurately as you can.

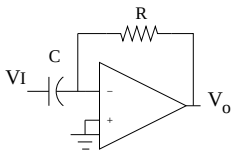


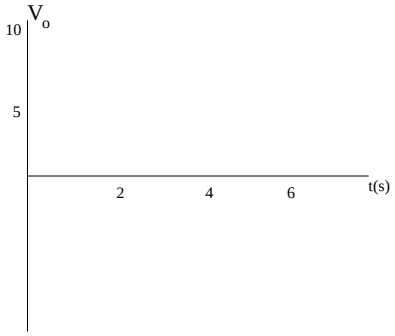
a)



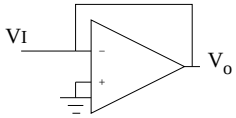


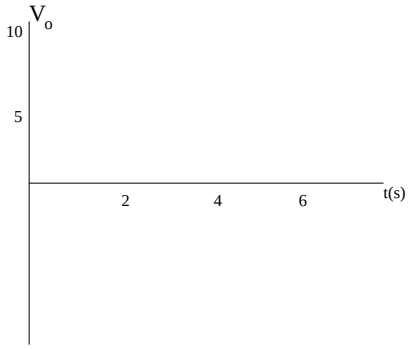
b)





c)





6. Two dielectrics are placed together as shown below:

region 1, $\varepsilon_r = 2$

region 2, $\varepsilon_r = 3$

If $|\vec{D}| = 2\frac{C}{m^2}$ in region 2 and it makes a 30^o angle relative to a vector normal to the interface, find:

(a) E_{normal} in region 1 (in V/m).

(b) $E_{tangential}$ in region 1 (in V/m).

7. Find the Fourier transform of the output of the system described by the differential equation:

$$\frac{dy(t)}{dt} + 10y(t) = 5x(t),$$

with the input $x(t) = 4e^{-10t}u(t)$.

$Y(\omega) =$

8. Write a 68HC11 assembly program including a subroutine and a calling "main" code segment and test the subroutine. The subroutine compares the 8-bit two's complement numbers in two tables. It will determine whether all the numbers in the first table are equal to or greater than the corresponding numbers in the second table. The subroutine will return 00 in the A accumulator if the condition is false, and FF if it is true. The references to the tables will be passed in the X and Y registers, and the table length will be in the A accumulator. In the main program, a pair of arrays of length 10 is used.

   (pseudocode with proper comments can be used if mnemonic can not be remembered.)