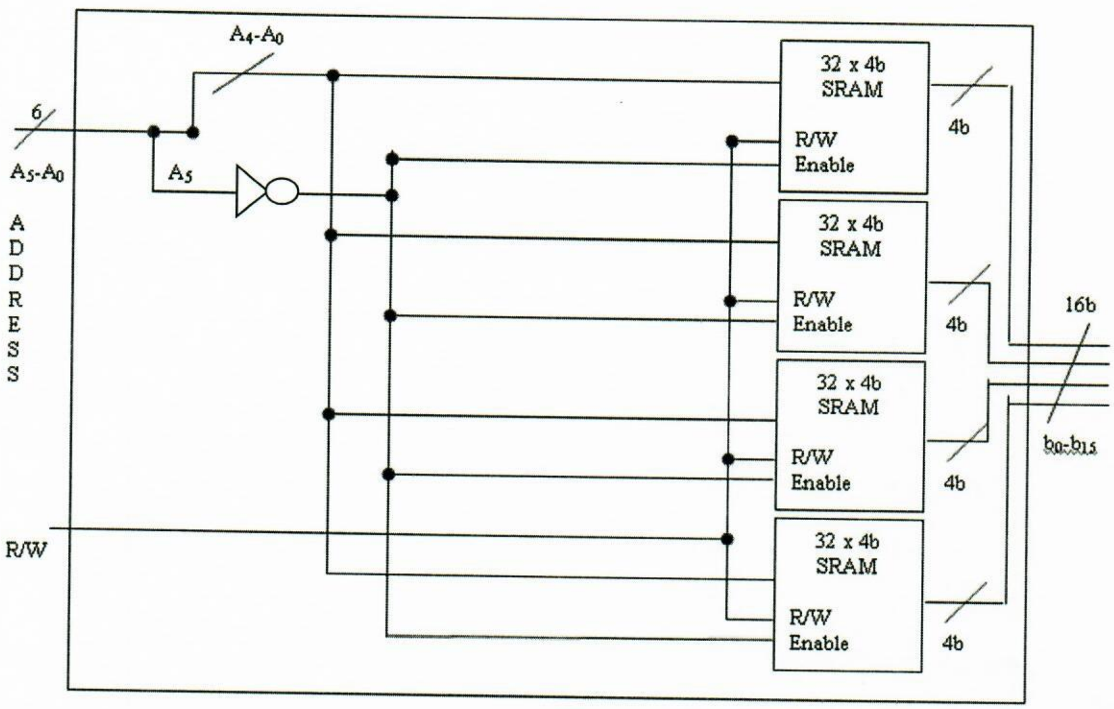
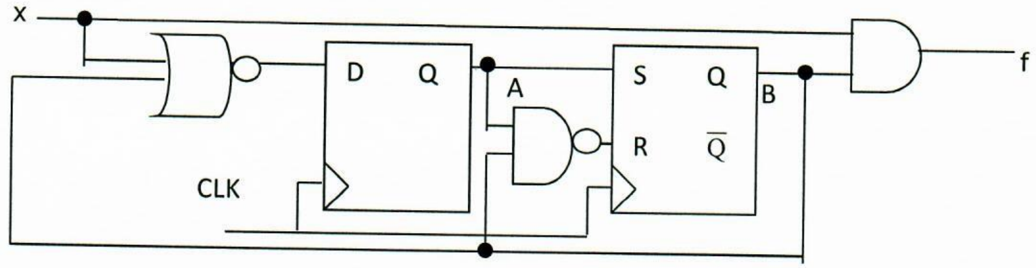
Problem: CM5 **Area: Integrated Circuits and Logic Design** **Code #_________**



a) What is the size of the memory array?(How many different words are stored in the memory array? What is the word size constructed from the four 32x4 SRAM devices?)

b) What is the address space for each of the four 32x4b SRAM devices? (What are the starting and ending addresses for each of the 32x4b SRAM devices?)

Problem: CM6 **Area: Integrated Circuits and Logic Design** **Code #________**



Given the sequential circuit above with the state variables A and B, externally applied input x and output f. Answer the questions for parts a and b below.

a) Fill in the missing values for the state table. **Show all relationships** used to fill in the state table values for *full credit.*

Present Input	Present State		Present Output	Next State		D Flip Flop Inputs	SR Flip Flop Inputs	
x	A	B	f	A*	B*	D_X	S_Y	R_Y
0	0	0						
0	0	1						
0	1	0						
0	1	1						
1	0	0						
1	0	1						
1	1	0						
1	1	1						

b) Using the state table from part a, draw the state transition diagram and use it to explain if the circuit has predictable behavior.

Problem: CM7 **Area: Integrated Circuits and Logic Design** **Code #_________**

Implement the function $F(A, B, C, D) = \prod M(0, 2, 4, 7, 9, 10, 13, 14, 15)$ using:

a) Two 3:8 decoders with active-high enable signals

b) One 8:1 multiplexer

c) One 4:1 multiplexer

Problem: CM8 **Area: Integrated Circuits and Logic Design** **Code #_________**

Answer the following questions.

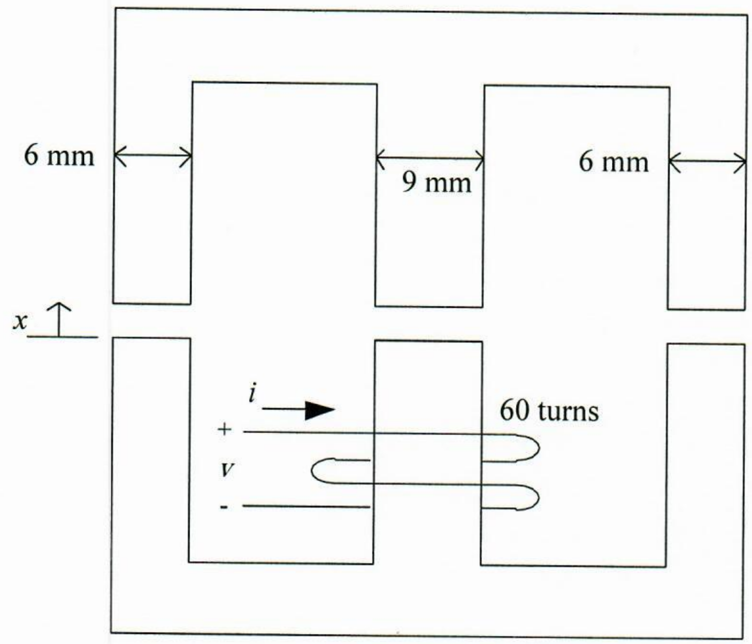
a) Draw the AND-OR Programmable Logic Array (PLA) for the following function: $F(A, B, C) = \prod M(0, 1, 3, 5)$

b) Draw the OR-AND PLA for the following function: $G(A, B, C) = \sum m(2, 4, 5, 7)$

c) You are designing a FSM to keep track of the mood of four students working in the digital design lab. Each student's mood is either HAPPY (the circuit works), SAD (the circuit blew up), BUSY (working on the circuit), CLUELESS (confused about the circuit), or ASLEEP (face down on the circuit board). How many states does the FSM have? What is the minimum number of bits necessary to represent these states?

Problem M1 **Power/Machinery** **Code #__________**

In the magnetic structure drawn below (not to scale), the lower half is fixed and the upper half is constrained to move in the x direction only. The permeability of the structure is infinite, and the depth into the page is 15 mm.



a. Sketch the magnetic equivalent circuit.

b. Solve for flux linkage in the coil.

c. Find the co-energy.

d. Find the force acting to close the air gaps.

Problem M2 **Power/Machinery** **Code #_________**

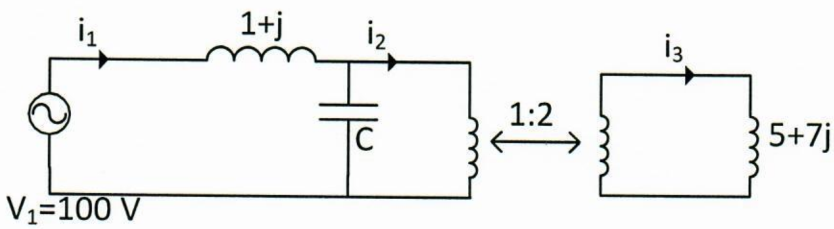
A three-phase, round-rotor synchronous generator is connected to a 4160 V, 60 Hz bus. The synchronous reactance is 3.5 Ω. It is generating 1.0 MW and delivering 500 kVAR to the bus.

a. Setting phase a line-to-neutral voltage $\hat{V}_a$ as your angle reference, find $\hat{I}_a$.
b. Determine E_a and δ.
c. Without changing field current, what is the maximum active (real) power that the generator can deliver? What is the reactive power flow in this condition?

Problem M3 **Power/Machinery** **Code #__________**

We have a 3-phase system with a single line diagram shown below (the transformer is Y-Y). If $V_1=100$, 1. what is the load current i_3, 2. what is the source current i_1, and 3. what is the total active and reactive power supplied by the source? (Ignore C for all of these items).

Assume that a capacitor C is connected as shown below to compensate for the reactive power of the source. If a source power factor of 1 (unity) is of interest, 4. what is the proper value for capacitor C?



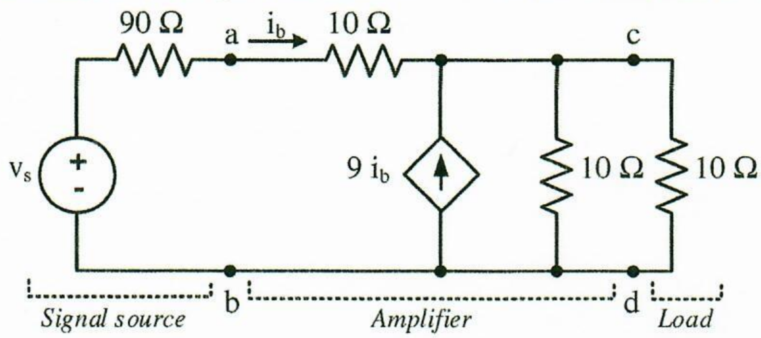
Problem M4 **Power/Machinery** **Code #__________**

For the following system, 1. Form the Y matrix, 2. If the Gauss Seidel method is

$$V_i^{j+1} = \frac{1}{Y_{ii}} \left[\frac{S_i^*}{V_i^{j*}} - \sum_{\substack{k=1:N \\ k \neq i}} Y_{ik} V_k^j \right]$$

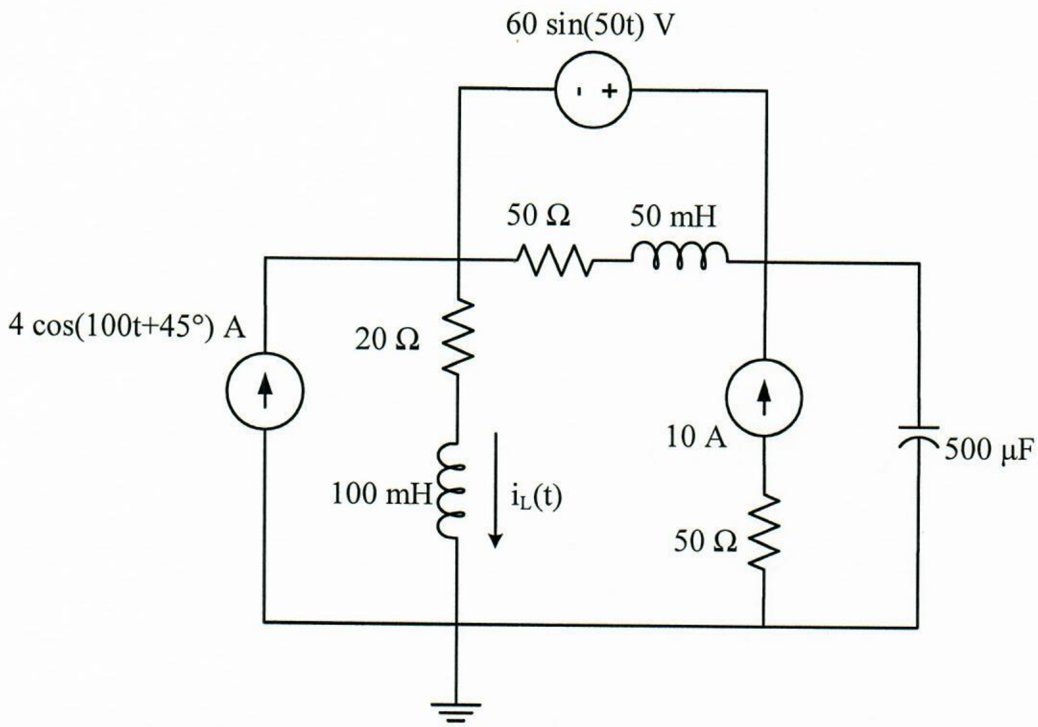
Then, perform 2 iterations of Gauss-Seidel to find the voltage of bus 2. Start from 1+0j.

Determine the Thévenin equivalent of the following circuit when the left-side network to nodes c and d is to be replaced with an equivalent Thévenin voltage and a Thévenin resistance. The right-side network is the load resistance of 10 ohms.



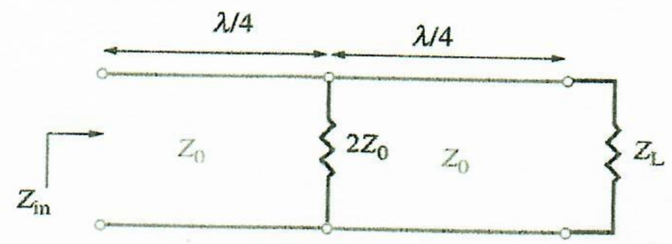
PROBLEM M6 CIRCUITS AND ELECTRONICS AREA Code #_____

Find the steady-state current, $i_L(t)$, in the following circuit.



Problem M10 Area: Waves, Devices, & Optics Code #________

For the lossless transmission line system with a characteristic impedance Z_0 shown below, find Z_{in} when the load impedance is: (a) $Z_L = \infty$ and (b) $Z_L = 0$.



Problem #M11 **Area: Waves & Devices Code #**

Consider a silicon (Si: a Col. IV material)) abrupt-junction pn diode in which only donors are on the n-side and only acceptors are on the p-side. T = 300 K. Important physical constants are:

Boltzmann's constant: $k = 1.38 \times 10^{-23}$ J/K = 8.62×10^{-5} eV/K

Planck's constant: $h = 4.14 \times 10^{-15}$ eV-s Electronic charge: $q = 1.60 \times 10^{-19}$ C

Carrier Mobilities $\mu_n = 1350$ cm²/V-s $\mu_p = 480$ cm²/V-s

Bandgap Energy of Si $E_g = 1.11$ eV Intrinsic Concentration $n_i = 1.50 \times 10^{10}$ cm^{-3} at 300 K

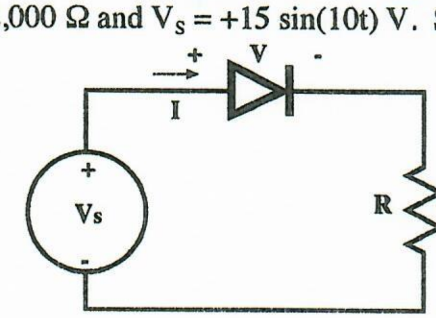
(a) Silicon (Si) is a column IV material on the periodic table and it is in the third row. Neon (Ne) is a column VIII material on the periodic table and it is at the end of the second row. If the electronic configuration for Neon is $1s^2 2s^2 p^6$, state the electronic configuration for Silicon.

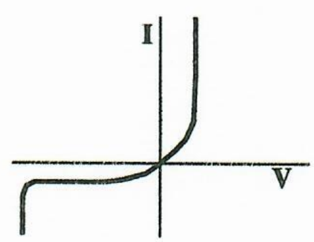
(b) The dopants are gallium (Ga: a Col. III material) and arsenic (As: a Col. V material) Select which dopant is on the n- and p-sides of the junction.

n-side	Ga	As	(circle one)
p-side	Ga	As	(circle one)

(c) The contact potential at 300 K is $V_o = 0.70$ V. Calculate the doping concentrations for the p and n sides if the doping concentrations on each side are equal..

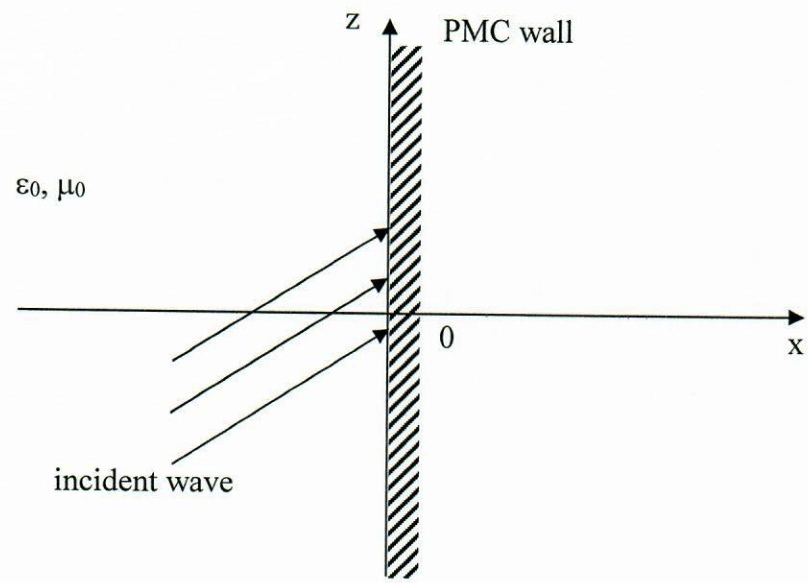
(d) Let the turn-on voltage be $V_{to} = 0.70$ V, the reverse saturation current be 0.50 mA, and the breakdown voltage be –10 V in the characteristic below. Calculate the current extremes if R = 2,000 Ω and $V_S = +15 \sin(10t)$ V. Sketch the load lines for these extremes on the IV plot.





Problem: <u>M12</u> Area: Waves, Devices, & Optics Code #: ____________

A uniform plane wave propagating in air given by $\overline{E}_i(x) = \pi e^{-j40\pi x - j30\pi z}(40\hat{z} - 30\hat{x})$ (V/m) is incident on a perfect magnetic boundary (PMC) wall located at x = 0. Find the magnetic field of the **reflected** wave.



Problem M-22 Communications/Signal Processing Code# ___________

Discrete time digital filters can be built as FIR or IIR filters, meaning Finite Impulse Response or Infinite Impulse Response. Answer both of the following questions, carefully explaining and justifying your answers for full credit. You may wish to discuss what properties of the frequency response, along with other characteristics of the filter are important to consider.

A) Give an example of an application when you would choose an FIR filter over an IIR filter.

B) Give an example of an application when you would choose an IIR filter over an FIR filter.

A set of symbols $S = \{a, b, c, d, e\}$ is found in a discrete source with the probability of occurrence being $P = \{0.1, 0.15, 0.30, 0.16, 0.29\}$.

1. What is the self-information of each symbol?
2. What is the entropy of the discrete source?
3. Use Huffman Coding to encode the symbols.
4. Compute the average coding length of the resulting Huffman code and compare it with the entropy.