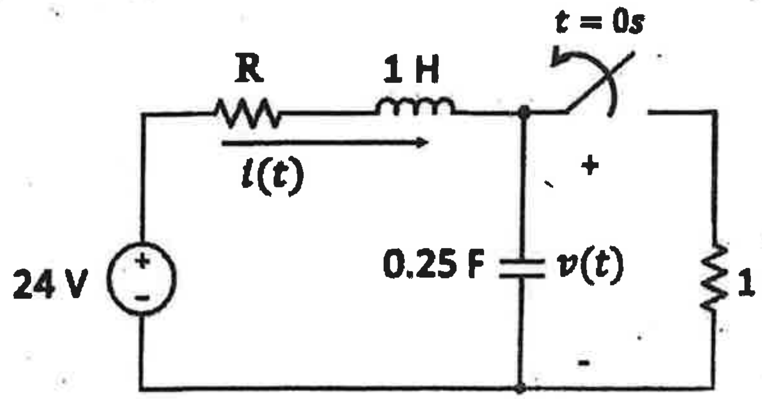
Find v(t) and i(t) for t>0 in the circuit below where R=4 ohm.

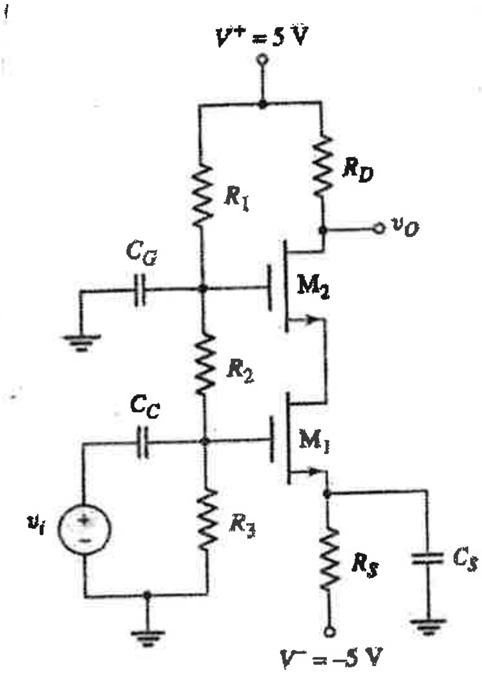


P4

For the NMOS cascode circuit shown below, the transistor parameters are:

$V_{TN1} = V_{TN2} = 1.2$ V, $K_{n1} = K_{n2} = 0.8$ mA/V^2, and $\lambda_1 = \lambda_2 = 0$. Let $R_1 + R_2 + R_3 = 300$ kΩ and $R_S = 10$ kΩ.

Calculate the value of R_1, R_2, R_3, and R_D such that $I_{DQ} = 0.4$ mA and $V_{DSQ1} = V_{DSQ2} = 2.5$ V



Problem : P6 **Area: Communications / Signal Processing** **Student Code: _____**

Refer to Fig. 1 for the system with ideal Continuous-to-Discrete (C-to-D) and Discrete-to-Continuous (D-to-C) converters.

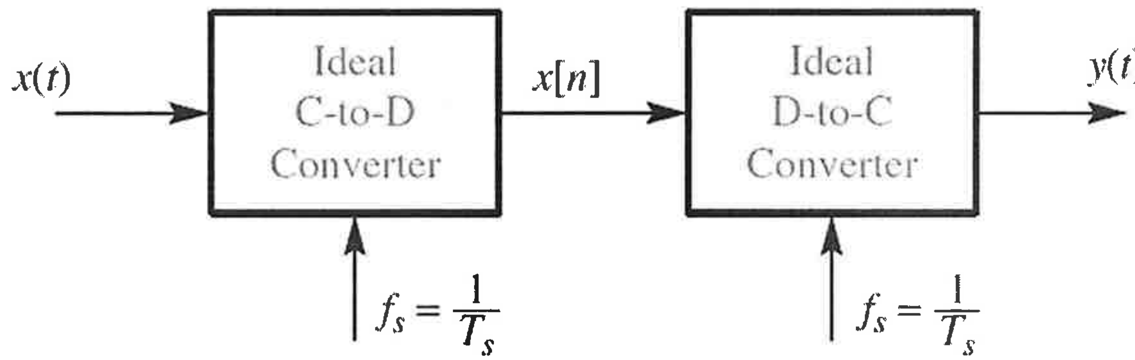


Figure 1: Ideal C-to-D and D-to-C system.

(a) Suppose that the output from the C-to-D converter is $x[n] = \cos(0.2\pi n)$, and the sampling rate of the C-to-D converter is $f_s = 8000$ samples/s. Determine a formula for the continuous-time sinusoidal input x(t) using the smallest frequency greater than 10000 Hz.

(b) Suppose the output from the C-to-D converter is $x[n] = \cos(0.25\pi n)$, the input signal is $x(t) = \cos(510\pi t)$, and the sampling rate (fs) of the C-to-D converter is less than 130 samples/s. Determine the largest possible sampling rate satisfying these three conditions.

Problem : P7 **Area: Communications / Signal Processing** **Student Code: _____**

Let a be a random variable which is uniformly distributed on the interval $[0,2]$. Define two random variables X and Y as

$$X \triangleq \min\{a, 2-a\},$$
$$Y \triangleq \max\{a, 2-a\},$$

and let $Z \triangleq \frac{Y}{X}$.

(1) Please derive the probability density function of X.

(2) Please derive the probability density function of Z.

(3) Please calculate the expectation of $\frac{X}{Y}$.

Problem :__P8___ Area:_____Communications/Signal Processing___________________ Student Code:____

A 9v battery is being used to light an incandescent bulb. The light is connected via a pair of 100m copper wires. Assume the diameter of the wire is 1 millimeter with a resistivity of 1.7×10^{-8} Ωm.

Assume the light bulb appears as a standard resistor in the circuit. What is the maximum power transfer possible to the light bulb?

Problem: P13 **Area** Power **Student Code**____

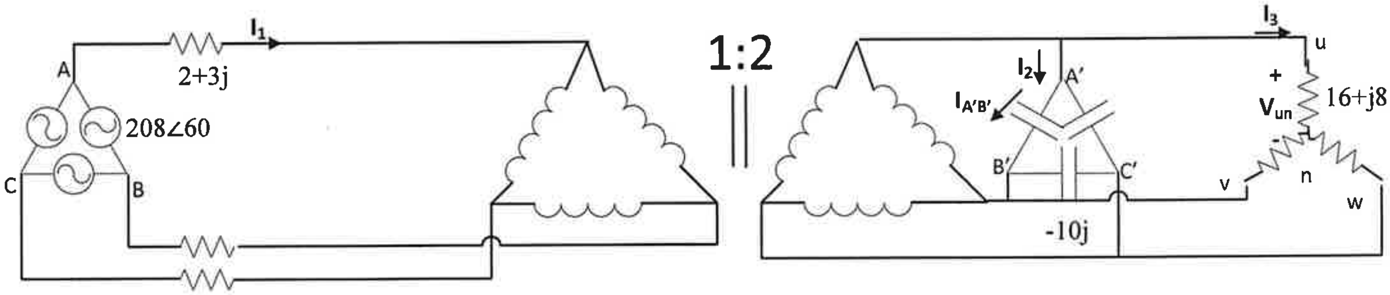
A 230 V, 60 Hz, three-phase, 4-pole induction motor has the following parameters: $R_1 = 0.15\ \Omega$, $R_2 = 0.2\ \Omega$, $X_1 = 0.7\ \Omega$, $X_2 = 0.6\ \Omega$, and $X_m = 5\ \Omega$. It is used with a VFD that is programmed to have 16 V boost. The VFD is set to have an output frequency of 20 Hz.

a) Determine the output voltage of the VFD.
b) Draw the wye-equivalent per-phase equivalent circuit (NOT the Thévenin, but the complete equivalent circuit). Label all elements numerically, including the voltage source connected to its terminals.
c) Determine the synchronous speed in RPM.
d) For a rotor electrical frequency of 1.0 Hz, determine the actual speed in RPM.

Problem: 14 **Area: Power** **Student Code: ______**

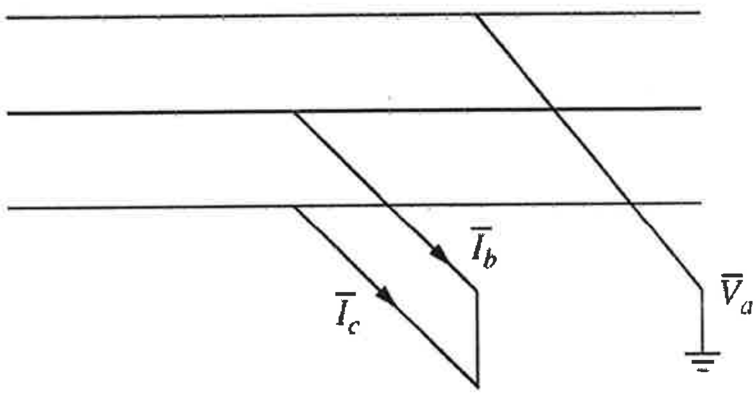
In the following circuit, find the following (both amplitude and angle):

a) I_1, I_2, and I_3 (60 points).
b) $I_{A'B'}$ (Capacitor current in the original delta form) (20 points)
c) 3-phase complex power of the source (20 points)



Problem: 15 **Area: Power** **Student Code:______**

At the general three-phase bus shown in the below figure, consider a simultaneous single line-to-ground fault on phase a and line-to-line fault between phases b and c, with no fault impedances. Obtain the sequence-network interconnection satisfying the current and voltage constraints.

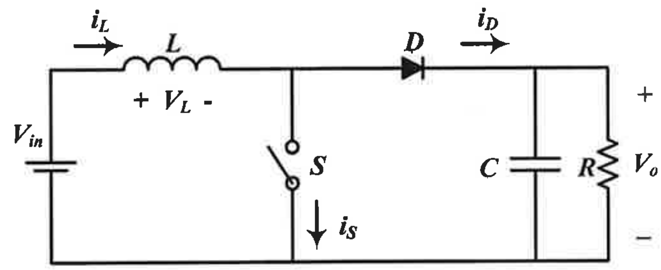


Fault conditions

Problem: 16 **Area: Power** **Student Code:______**

A Boost dc-dc converter has the following parameters: $V_{in} = 100$ V, $d = 0.5$, $L = 500$ μH, and $f_{sw} = 100$ kHz. Start from steady state.

C = infinity, R = 100.



a) Find the maximum and minimum value of the inductor current.

b) Accurately plot the waveform of the inductor current.

c) Find the average value of the switch current.

d) Find the input power.

Problem: P21 **Area: Computational Intelligence** **Code #________**

Answer the questions for parts **a** and **b** below.

(a) In developing an optimal multilayer perceptron with the back-propagation algorithm, what variable parameters have to be decided upon?

(b) Describe considerations for training a multi-layer perceptron with back-propagation algorithm for a 3-class dataset with 10 features. Individual feature value ranges vary from [0,1] to [-1000,1000]. There are approximately 3 times as many feature vectors for classes 1 and 2 than there are for class 3.

Problem: P22 **Area: Computational Intelligence** **Code #________**

Answer the questions for parts a and b below.

(a) Define supervised and unsupervised learning.

(b) Briefly describe two algorithms that use supervised learning and two algorithms that use unsupervised learning.

(c) How are the trained supervised and unsupervised algorithms applied to independent test sets for classification decisions?

Problem: P23 **Area: Computational Intelligence** **Code #_________**

Answer the questions for parts a and b below.

(a) Describe Kohonen's Self Organizing Map algorithm. What is the principal application of SOM?

(b) Describe the learning vector quantization (LVQ) algorithm.

Problem: P24 **Area: Computational Intelligence** **Code #_________**

Answer the following questions.

(a) Describe the different types of hardware evolution. Provide diagrams where possible.

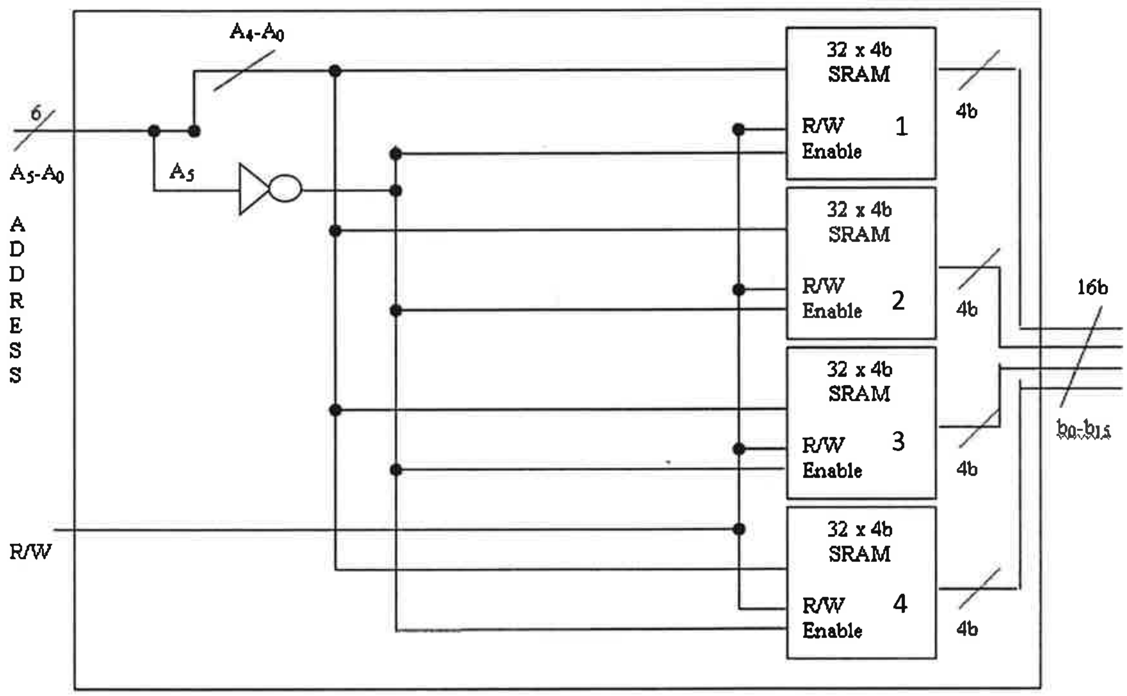
(b) Define the following terms:

(i) Embryonics

(ii) Adaptive Devices, Circuits and Systems

(iii) Immunotronics

Problem: P29 **Area: Integrated Circuits and Logic Design** **Code #________**

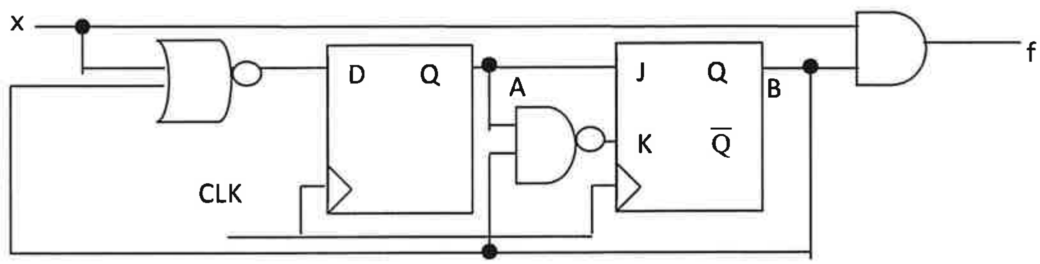


a) What is the size of the memory array?(How many different words are stored in the memory array? What is the word size constructed from the four 32x4 SRAM devices?)

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?)

Device Number	Starting/Beginning Address (in binary)	Ending/Highest Address (in binary)
1		
2		
3		
4		

Problem: P30 **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	JK Flip Flop Inputs	
x	A	B	f	A*	B*	D_X	J_Y	K_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: P31 **Area: Integrated Circuits and Logic Design** **Code #________**

Implement the function $F(A, B, C, D) = \sum m(0,3,4,5,7,8,10,13)$ using:

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

b) One 8:1 multiplexer

Problem: P32 **Area: Integrated Circuits and Logic Design** **Code #__________**

Answer the questions for parts **a** and **b** below.

a. Simplify the logic expression $F(a,b,c) = (\bar{a}+\bar{b})(\bar{c}+\bar{b})+(\bar{a}+b)c$ using algebraic manipulation to obtain a logic expression that uses as few gates as possible (exclude inverters from the total gate count). *Show your work for full credit.* DO NOT USE K-MAPS.

b. Construct the truth table for $F(a,b,c) = (\bar{a}+\bar{b})(\bar{c}+\bar{b})+(\bar{a}+b)c$.

Problem: P33 **Area: Networking, Security, and Dependability** **Student Code: ____**

This problem has three parts. For full credit, you must answer all three parts correctly.

The table below is a routing table using CIDR. Address bytes are in hexadecimal. Leading zeroes are dropped for each byte, e.g., 02 is written as 2. The notation "/12" in C4.50.0.0/12 denotes a mask with 12 leading 1 bits: FF.F0.0.0. Conversion to decimal is not necessary. Conversion of parts of the information to binary is likely to be necessary.

Complete the table and determine the next hop for a packet with each of the following destination addresses, assuming the match with the longest prefix is selected. You can mix binary and hex in the same byte, if you clearly label values to differentiate the binary parts from hex. Use an "x" to represent any bit or byte whose value does not affect the match. One row has been filled out for you as an example.
Show your work. No work = no credit.

Prefix/Length	Next Hop	Values required for match			
		Byte 1	Byte 2	Byte 3	Byte 4
C4.5E.2.0/23	A				
C4.5E.3.0/22	B				
C4.5E.C0.0/19	C				
C4.5E.40.0/18	D	C4	5E	01xx xxxx	x
C4.4C.0.0/14	E				
C0.0.0.0/2	F				
80.0.0.0/1	G				
default	H				

a. C4.5E.D1.2

b. C4.5E.3.42

c. C4.4B.31.2E

Problem: P34 **Area: Networking, Security, and Dependability** **Student Code: ____**

This problem has two parts. For full credit, you must answer both parts correctly.

In communication between an Earth-based data source and a satellite, each data frame includes 40 bytes of header and 3960 bytes of data. No acknowledgements are sent or expected for frames that are successfully received. If the satellite detects a missing or corrupt data frame, it requests retransmission by using a 40-byte NAK frame. The error rate for data frames is 10%, and the error rate for NAK frames and retransmissions is negligible. Answer both questions below. Show your work. Fractional answers are acceptable.

a. What is the average number of bytes associated with successful communication of a frame? Include the original transmission, any NAKS, and any retransmissions. Remember that on average, one out of every ten frames will be received in error and will require a NAK and a retransmission for successful communication.

b. What is the average end-to-end delay associated with successful communication of a frame? Remember to include the average times associated with NAK and retransmission. Assume a data rate of 800 kbps and roundtrip propagation delay of 320 ms.

Problem: P35 Area: Networking, Security, and Dependability **Student Code: ____**

This problem has four parts. For full credit, you must answer all four parts correctly.

A file of 10^6 bits is transmitted in blocks of 10^3 bits. Assume that bit errors and successive transmissions are independent of each other. The bit error rate for the channel is 10^{-6}. Assume that at most one single-bit error occurs per block. Answer the questions below to compare the overhead associated with error detection and error correction. Show your work.

a. What is the expected number of errors in a block?

b. Assume that single-bit (per block) parity is used for error detection. If an error is detected by the receiver in a particular block, that block is retransmitted. Assume that a retransmission is immune to error, i.e., at most one retransmission will be necessary for a given block. Determine the total number of bits that the source should expect to send for successful receipt of the file by the destination. This will include all bits associated with error detection and retransmission.

c. Now assume that instead of error detection, single-bit error correction is used. Determine the total number of bits that the source should expect to send for successful receipt of the file by the destination. Assume that the error correction method uses the minimum number of bits that can be used to correct a single error.

d. Assume that you don't know the bit error rate, but you want to determine the maximum error rate at which error detection with single-bit parity followed by retransmission in case of error (part b), is more efficient than single-bit error correction with an optimal code (part c)? You are not being asked to find the value. You are being asked to show the equation or identity that you would use to find the break-even error rate.

Problem: P36 Area: Networking, Security, and Dependability **Student Code: ____**

This problem has three parts. For full credit, you must answer all three parts correctly.

a. In general, is asymmetric encryption more, less, or about as secure as symmetric encryption? Assume that the key lengths are equal. Justify your answer.

b. Recall RSA, where the ciphertext, C, of a plaintext message, M, is generated as $C = M^e \bmod n$, and decryption recovers $M = C^d \bmod n$. In RSA, it is often recommended to choose a small value for e to increase efficiency. A common choice is 3. Show why $e = 2$ is not a valid choice.

c. Alice and Bob have the same modulus, n, for RSA, and respective public keys e_A and e_B, where $\gcd(e_A, e_B) = 1$. Charles sends both of them the same message, M, encrypted with these keys, resulting in respective ciphertexts c_A and c_B. Eve intercepts both c_A and c_B. Show how Eve can find M without factoring the modulus.