ELECTRICAL AND COMPUTER ENGINEERING
PhD QUALIFYING EXAMINATION

Session 1

January 7, 2008

Be sure to put your ID number on each sheet that has material to be graded. Do not put your name on any sheet.

There are 14 equally weighted problems. You are to SELECT ANY EIGHT of these to answer. You must make it very clear which eight that you choose. (If it is not clear, then the first eight problems that you attempt will be graded.) Indicate your selections in two ways:

1. Circle below which eight problems that you want graded.
2. If you write anything other than your ID number on the page of a question that you do not graded, the cross out that page with a large X from corner to corner.

Circle the eight questions that you want graded:

1

2

3

4

5

6

7

8

9

10

11

12

13

14

Do all work on the paper supplied to you. Do not write on the back of any page.

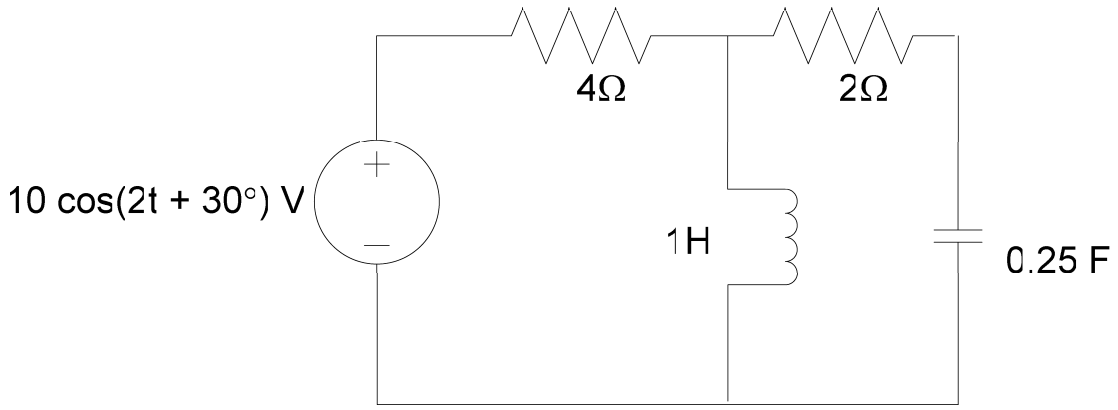
Problem 1-1 ID # _____

A finite state machine is defined by the state table below. Find a minimized state table using state minimization techniques. Show your work.

Present State	Next State		Output z
	w=0	w=1	
A	B	C	1
B	D	C	1
C	F	E	0
D	B	E	1
E	F	C	0
F	G	D	0
G	H	G	0
H	H	A	1

Problem 2-1 ID # _____

Find the average real power and reactive power for each element. Use the convention that POSITIVE power is ABSORBED and NEGATIVE power is GENERATED by the element. (The expression given for the voltage source is PEAK, NOT RMS.) Show your steps clearly.

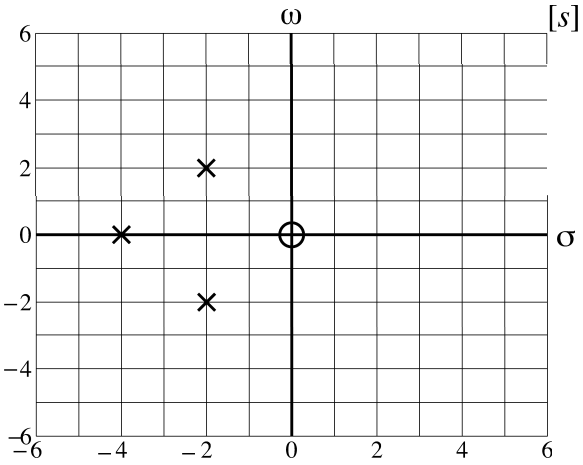


Problem 3-1 ID # _____

The transfer function of a continuous-time linear, time-invariant system has the pole-zero map shown below. It can be written in the form

$$\mathrm{H}(s) = K\frac{(s-z_1)(s-z_2)\cdots(s-z_M)}{(s-p_1)(s-p_2)\cdots(s-p_M)}$$

If $K=1$ and the signal $\mathrm{x}(t)=10\cos(2\pi t)$ is applied to this system find the response of the system $\mathrm{y}(t)$.



Problem 4-1 ID # _____

$$\lim_{x \to \infty} \frac{x - \sin x}{x^3} = ?$$

Problem 5-1 ID # _____

Given the following class definition and implementation and the main function, please write down the program output.

```
#include <iostream>
using namespace std;

class CreateDestroy1
{
    public:
        CreateDestroy1() { cout << "con1" << endl; }
        ~CreateDestroy1() { cout << "des1" << endl; }
};

class CreateDestroy2 : public CreateDestroy1
{
    public:
        CreateDestroy2() : CreateDestroy1()
        {
            cout << "con2" << endl;
        }
        ~CreateDestroy2() { cout << "des2" << endl; }
};

class CreateDestroy3 : public CreateDestroy2
{
    public:
        CreateDestroy3() { cout << "con3" << endl; }
        ~CreateDestroy3() { cout << "des3" << endl; }
};

int main()
{
    CreateDestroy3 c1;
    CreateDestroy3 *c2Ptr;

    for (int i=0; i<2; i++)
        CreateDestroy2 cd;

    c2Ptr = new CreateDestroy3;

    return 0;
}
```

The output of the program is:

Problem 6-1 ID # _____

A geometric random variable (r.v.) X with parameter p satisfies $\Pr\{X>k\} = (1-p)^k$. Let X_1 denote a geometric r.v. with parameter p_1 and X_2 a geometric r.v. with parameter p_2. What is the distribution of the random variable $Y = \min\{X_1, X_2\}$?

Problem 7-1 ID # _____

Here is a series of address references given as word addresses: 1,4,8,5,20,17,19,56,9,11,4,43,5,6,9,17

a) Assuming a direct cache of total size 16 words with two-word blocks that is initially empty, label each reference in the list as a hit or a miss and show the final contents of the cache.

b) Assuming a 2-way set associative cache of total size 16 words with two-word blocks that is initially empty, label each reference in the list as a hit or a miss and show the final contents of the cache.

Problem 8-1 ID # _____

Let T be a tree whose nodes store strings. Give an efficient algorithm that computes and prints, for every node v of T, the string stored at v and the height of the subtree rooted at v.

Problem 9-1 ID # _____

CPU scheduling. Here is a table of processes and their associated arrival and running times.

Process ID	Arrival Time	Expected CPU Running Time
Process 1	0	5
Process 2	3	5
Process 3	5	3
Process 4	7	2

a) Show the scheduling order for these processes under First-In-First-Out (FIFO), Shortest-Job First (SJF), and Round-Robin (RR) with a quantum = 1 time unit. Assume that the context switch overhead is 0 and new processes are added to the beginning of the queue except for FIFO.

Time	FIFO	SJF	RR
0			
1			
2			
3			
…			

b) For each process in each schedule above, indicate the queue wait time and turnaround time (TRT). The queue wait time is the total time a thread spends in the wait queue. The turnaround time is the time a process takes to complete after it arrives.

	Process 1	Process 2	Process 3	Process 4
FIFO queue wait				
FIFO TRT				
SJF queue wait				
SJF TRT				
RR queue wait				
RR TRT				

c) For each of the three scheduling algorithms, list the pros and cons of the algorithm, and give one example situation where each algorithm would be a bad choice.

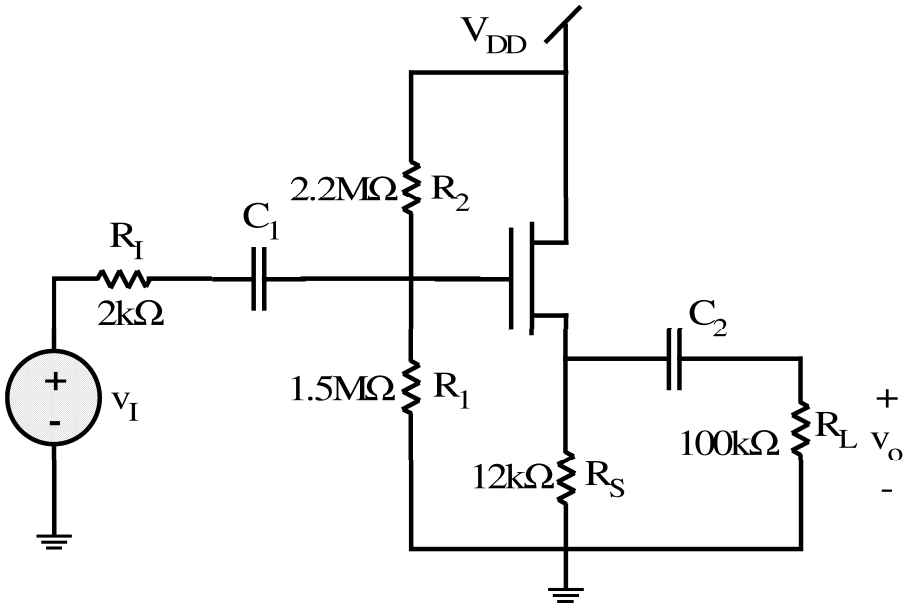
Problem 10-1 ID # _____

Use the LU decomposition to find the rank of the matrix $A = \begin{bmatrix} 5 & -1 & 3 & -2 \\ -1 & 10 & 5 & -8 \\ 3 & 5 & 5 & -6 \\ -2 & -8 & -6 & 8 \end{bmatrix}$

Problem 11-1 ID # _____

For the circuit shown below:

A) What kind of amplifier is this?
B) Draw the low-frequency and midband equivalent circuits
C) What are the lower-cutoff frequency and the midband gain of the amplifier if the transistor is biased at 0.75V above threshold with a Q-point = (0.1mA, 8.8V), $C_1 = 4.7\mu F$, $C_3 = 0.1\mu F$?
D) What is the value of V_{DD}?



Problem 12-1 ID # _____

A balanced, three-phase, 60 Hz induction motor delivers rated output power. The synchronous speed for this machine is 3600 rpm. The rotor circuit frequency (i.e., the slip frequency or f_2) is 3Hz. Determine:

1) The number of poles.
2) The value of the slip.
3) The rotor speed.
4) The speed of the rotor field relative to the rotor structure.
5) The speed of the rotor field relative to the stator structure.
6) The speed of the rotor field relative to the stator rotating field.

Problem 13-1 ID # _____

Consider a dielectric slab of thickness "d" and relative dielectric constant ε_r=9. Determine the fraction of the incident average power density reflected by the structure. Assume all media are lossless and nonmagnetic, and we have normal incidence wave at 500 MHz. Calculate the transmitted fields, if the incident electric field is 1V/m.

Problem 14-1 ID # _____

A BPSK signal can be transmitted via DSB in the following manner, $x_c(t) = m(t)\cos 2\pi f_c t$ where

$$m(t) = \begin{cases} -1 \Rightarrow \text{logic 0} \\ +1 \Rightarrow \text{logic 1} \end{cases}$$

Using a square law device (i.e. $v_{out}(t) = v_{in}^2(t)$, any number of summers, filters, and frequency dividers, design a system that will detect or extract $m(t)$ from the above transmitted DSB signal. Show your design in labeled block diagram form and specify mathematical expression of each of the output blocks.

Problem _-_ ID # _____