

HOURLY EXAMINATION #3

LAST Name (use capital letters): _____
First Name (use capital letters): Solution
Signature: _____

Circle your section: AL1(3pm)-Trick

BL1(1pm)-Brunet

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD

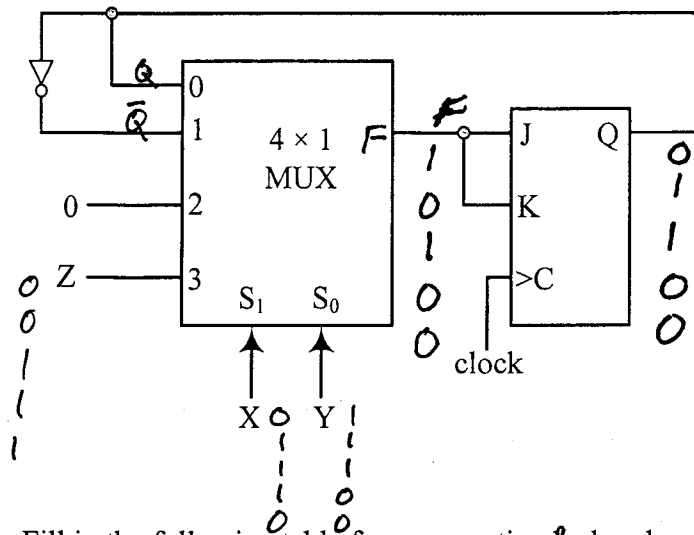
Problem	Value	Score
1	20	
2	20	
3	20	
4	20	
5	20	
Total	100	

A. Write or print clearly. Answer each problem on the exam itself. If you need extra paper, there is an extra sheet at the end of this exam. Clearly identify the problem number on any additional pages. The ASCII Code, the Morse Code alphabet, the UPC code, numbers and properties for log base 2 are given at the end of the exam.

B. In order to receive partial or full credit, **you must show all your work**, e.g., your solution process, the equation(s) that you use, the values of the variables used in the equation(s), etc. You must also include the unit of measurement in each answer.

Students caught cheating on this exam will earn a grade of F for the entire course. Other penalties may include suspension and/or dismissal from the university.

Problem 1 (20 points)



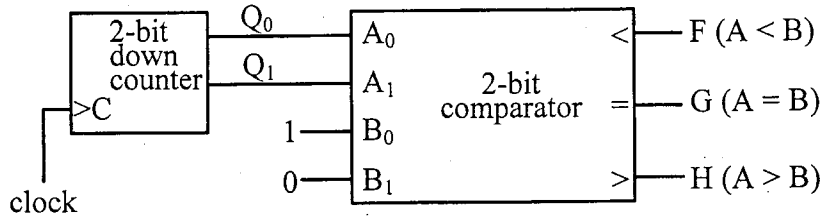
Fill in the following table for consecutive clock pulses.

t	0	1	2	3	4	
MUX Port select {	X	0 ^P 1	1 ^P 3	1 ^P 3	1 ^P 2	0 ^P 0
	Y	1	1	1	0	0
	Z	0	0	1	1	1
MUX output {	J	1	0	1	0	0
	K	1	0	1	0	0
	Q	0	1	1	0	0

Problem 2 (20 points)

Check the most appropriate answer for all questions below.

a)

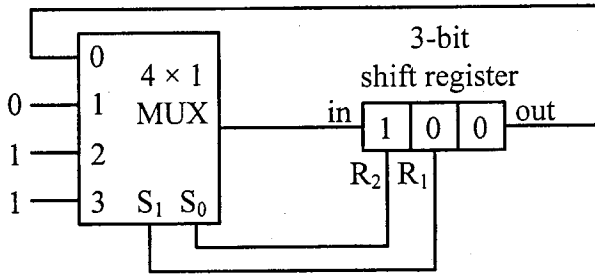


$B = (1)_{10}$
 $A: 0\ 3\ 2\ 1\ 0\ 3\ \dots$
 $F: 1\ 0\ 0\ 0\ 1$
 period = $4T$

The duty cycle of F is: 0% 25% 33% none of the previous

The period of G is: T 2T 3T none of the previous
 T is the clock period.

b)



(At $t = 0$; clock is omitted.)

After 2 clock pulses (at $t = 2$) the register contains:

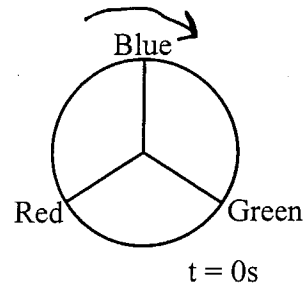
- 101 011
 000 111
 none of the previous

t	S	in	R ₂	R ₁	R ₀
0	1	0	1	0	0
1	2	1	0	1	0
2	1	0	1	0	1

↑
 MUX Port selected

Problem 3 (20 points)

A wheel has 3 evenly spaced spokes. Each spoke is of a different color (see figure). The wheel is rotating at a rate of $f = 12$ revolutions per second. Show work of all parts.



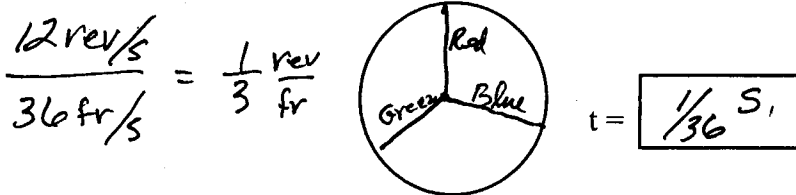
- a) If the wheel is filmed at a sampling frequency $f_s = 36$ frames per second, is there aliasing?

YES

NO

$$f_s > f_n = 24 \text{ Hz}$$

Draw the first frame seen after $t = 0$ s; indicate time, too.



- b) For what sampling frequency would the wheel seem immobile? (Give the largest number possible.)

$$1 \text{ rev in } \frac{1}{12} \text{ sec.}, \text{ so } f_s = 12 \text{ fr/sec}$$

\rightarrow appears stationary

$$f_s = 12 \text{ fr/s}$$

- c) For what ranges of sampling frequencies would the wheel seem to be going backward? (Give largest numbers possible.)

$$f_{\text{Nyquist}} = 24 \text{ Hz}; \quad f_{\text{Solding}} = 12 \text{ Hz}, \quad f_s > 24 \text{ Hz} \text{ no aliasing}$$

SO

$$12 \text{ Hz} < f_s < 24 \text{ Hz}$$

Problem 4 (20 points)

- a) (10 pts.) Information is encoded in the 7-bit ASCII code. In transmission tests it is discovered that on the average a single bit error occurs in every few hundred characters received. A decision is made to add the capability to detect and correct single bit errors. Two schemes are proposed: [a] send the message in triplicate, or [b] add an even parity bit to the code for each character and, for every block of 10 characters to be transmitted, add a redundancy check code word in order to correct any single error that is detected. Compute the compression ratio and savings if Scheme [b] is used instead of Scheme [a].

a) $3 * 7 \text{ bits/char} * 10 \text{ char/block} = 210 \text{ bits/block}$ 3

b) $(7+1) \text{ bits/char} * (10+1) \text{ char/block} = 88 \text{ bits/block}$ 3

$$R_{\text{compression}} = \frac{210}{88} = 2.39$$

$$\text{Savings} = \frac{210 - 88}{210} * 100\% = 58.1\%$$

- b) (10 pts.) The relative frequency for a message consisting of the following six symbols is A = 1/3, B = 5/24, C = 1/6, D = 1/6, E = 1/12, F = 1/24. The Huffman code for these symbols is A(11), B(01), C(00), D(101), E(1001), F(1000). Compute the average code length, and the savings achieved over the minimum fixed length code.

③
$$L_{\text{avg}} = 2 * \frac{1}{3} + 2 * \frac{5}{24} + 2 * \frac{1}{6} + 3 * \frac{1}{6} + 4 * \frac{1}{12} + 4 * \frac{1}{24}$$

$$= \frac{4 + 10 + 8 + 12 + 8 + 4}{24} = \frac{58}{24} = 2.42 \text{ bits/symbol}$$

Fixed Code: $2^2 \leq 6 \text{ symbols} < 2^3$, so 3 bits required.

$$R_{\text{comp}} = \frac{6 * 3}{6 * 2.42} = 1.24$$

$$\frac{1.24 - 1}{1.24} = 0.19$$

$$L_{\text{avg}} = 2.42 \text{ bits/symbol}$$

5 pts.
②

$$\text{Savings} = \frac{3 - 2.42}{3} * 100\% = 19.3\%$$

5 pts.) $\frac{7}{36}$

$$\frac{0.58}{3} = 0.193$$

