*Name:*_____
ID: _____

ECS 17: Data, Logic, and Computing
Midterm 1
February 7, 2023

Notes:

1) The midterm is open book, open notes.
2) You have 50 minutes, no more: I will strictly enforce this.
3) The midterm is graded over 70 points
4) You can answer directly on these sheets (preferred), or on loose paper.
5) Please write your name at the top right of each page you turn in!
6) Please, check your work! **Also, do show your work**

Part I (6 questions, each 5 points; total 30 points)
(These questions are multiple choices; in each case, find the most **plausible** answer)

1) ***How many songs could you store on 1GByte, if those songs were each 5 min long, sampled at 44.1 kHz, with each data point stored on 16 bits, in stereo (i.e., with two microphones)? Assume no compression.***
   a. About 10 songs
   b. About 20 songs
   c. About 40 songs
   d. About 60 songs

2) ***Let X be the number with the hexadecimal representation #89 and Y the number whose binary representation is $(1111111)_2$; which of these numbers T (in hexadecimal form) satisfies X-T=Y?***
   a. #A
   b. #B
   c. #C
   d. #D

3) ***The hexadecimal equivalent of $(1110010)_2$ is***
   a. #82
   b. #71
   c. #72
   d. #F2

4) ***The heart rate of a hummingbird can go as high as 1260 beats per minute. Which of these sampling rates would be appropriate to monitor this heart rate? (Circle all that applies)***
   a. 1 Hz,
   b. 21 Hz,
   c. 42 Hz,
   d. 45 Hz.

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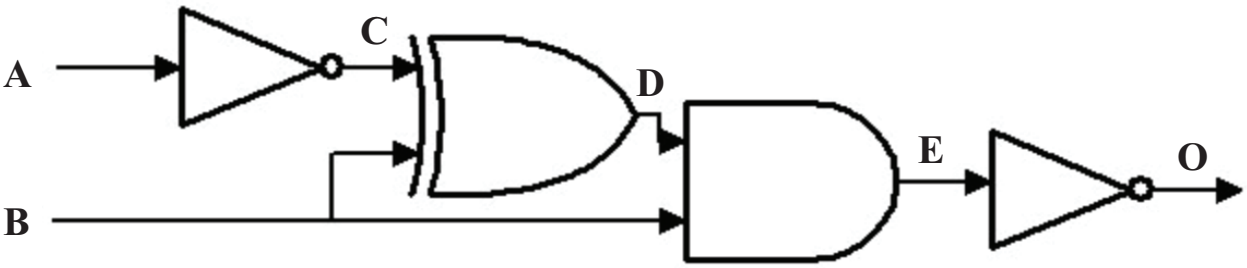
5) ***If we sum the ASCII representations of the letters in the word A_ (where _ is unfortunately unknown), we get the hexadecimal #94. What is this letter currently represented with _ ?***
   a. S
   b. T
   c. M
   d. L

6) ***You take a picture with a digital camera, and you know that this picture requires 64 Mbytes of storage (without compression). Assuming that each pixel is stored on 32 bits, how many pixels do the image contain?***
   a. 12 Mega pixels
   b. 16 Mega pixels
   c. 2 Mega pixels
   d. 32 Mega pixels

Part II (two problems, each 10 points; total 20 points)

1) Complete the logic table corresponding to the logic gate shown below. Which gate is it equivalent to? ***(10 points)***



A	B	C	D	E	O
1	1				
1	0				
0	1				
0	0				

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2) Using only a logic table, show that $\overline{\overline{A + B}(\bar{B} + C)} = A + B$ ***(10 points)***

Part III (two problems, each 10 points; total 20 points)

1) A very special island is inhabited by knights, knaves, and spies. Knights always tell the truth, knaves always lie, and spies may tell the truth or lie. This island is special as its empress has set up the following rule: ``A knight can only marry a knave and a knave can only marry a knight". Clearly, a spy can only marry a spy. You meet two couples, let us call them Mr. and Mrs. Davis, and Mr. and Mrs. Dixon. Mr. Davis says, ``Mr. Dixon is a knight", Mrs. Davis says, ``This is true: Mr. Dixon is a knight", and Mrs. Dixon says, "I agree: my husband is a knight". What are each of the four people? Show your work (***10 points***)

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2) You arrive in a country called Transylvania whose inhabitants are humans and vampires. Humans always tell the truth, while vampires always lie. However, both humans and vampires can be sane or insane. If an inhabitant is insane, she will believe that a truth statement is false, and a false statement is true. Sane inhabitants believe that truth statements are true and false statements are false. Thus, sane humans and insane vampires make only true statements, while insane humans and sane vampires make only false statements. You meet two inhabitants, Alex and Bill. You know that one of them is a human, and the other is a vampire. Alex tells you: "we are both insane", while Bill tells you that "at least one of us is sane". From this, can you find which one is the vampire? Show your work ***(10 points)***

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Appendix A: ASCII table

Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char	Dec	Hex	Char
0	00	Null	32	20	Space	64	40	@	96	60	`
1	01	Start of heading	33	21	!	65	41	A	97	61	a
2	02	Start of text	34	22	"	66	42	B	98	62	b
3	03	End of text	35	23	#	67	43	C	99	63	c
4	04	End of transmit	36	24	$	68	44	D	100	64	d
5	05	Enquiry	37	25	%	69	45	E	101	65	e
6	06	Acknowledge	38	26	&	70	46	F	102	66	f
7	07	Audible bell	39	27	'	71	47	G	103	67	g
8	08	Backspace	40	28	(	72	48	H	104	68	h
9	09	Horizontal tab	41	29	)	73	49	I	105	69	i
10	0A	Line feed	42	2A	*	74	4A	J	106	6A	j
11	0B	Vertical tab	43	2B	+	75	4B	K	107	6B	k
12	0C	Form feed	44	2C	,	76	4C	L	108	6C	l
13	0D	Carriage return	45	2D	-	77	4D	M	109	6D	m
14	0E	Shift out	46	2E	.	78	4E	N	110	6E	n
15	0F	Shift in	47	2F	/	79	4F	O	111	6F	o
16	10	Data link escape	48	30	0	80	50	P	112	70	p
17	11	Device control 1	49	31	1	81	51	Q	113	71	q
18	12	Device control 2	50	32	2	82	52	R	114	72	r
19	13	Device control 3	51	33	3	83	53	S	115	73	s
20	14	Device control 4	52	34	4	84	54	T	116	74	t
21	15	Neg. acknowledge	53	35	5	85	55	U	117	75	u
22	16	Synchronous idle	54	36	6	86	56	V	118	76	v
23	17	End trans. block	55	37	7	87	57	W	119	77	w
24	18	Cancel	56	38	8	88	58	X	120	78	x
25	19	End of medium	57	39	9	89	59	Y	121	79	y
26	1A	Substitution	58	3A	:	90	5A	Z	122	7A	z
27	1B	Escape	59	3B	;	91	5B	[	123	7B	{
28	1C	File separator	60	3C	<	92	5C	\	124	7C	|
29	1D	Group separator	61	3D	=	93	5D	]	125	7D	}
30	1E	Record separator	62	3E	>	94	5E	^	126	7E	~
31	1F	Unit separator	63	3F	?	95	5F	_	127	7F	□

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Appendix B: Binary to Hexadecimal

Base 10	Base 2	Base 16
0	0000	0
1	0001	1
2	0010	2
3	0011	3
4	0100	4
5	0101	5
6	0110	6
7	0111	7
8	1000	8
9	1001	9
10	1010	A
11	1011	B
12	1100	C
13	1101	D
14	1110	E
15	1111	F

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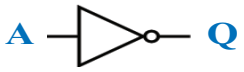
<td> 
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<td>$\overline{A}$ or $\neg A$</td>
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<tr><th>Input</th><th>Output</th></tr>
<tr><th>A</th><th>Q</th></tr>
<tr><td>1</td><td>0</td></tr>
<tr><td>0</td><td>1</td></tr>
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<tr>
<td>OR</td>
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<td>A+B or A∨B</td>
<td>
<table>
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<tr><th>A</th><th>B</th><th>Q</th></tr>
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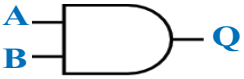
<td> 
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<tr>
<td>XOR</td>
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<td>A⊕B</td>
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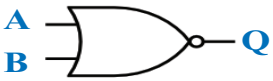
<td> 
</td>
<td>$\overline{A+B}$ or $\overline{A \vee B}$</td>
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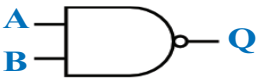
<td> 
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