CDS 130-001 Computing for Scientists

Midterm Exam - Sample Exam Solution
(Oct. 13, 2010)

This is a closed-book closed-computer exam. Calculators are allowed. Your answer should be on the space provided immediately following each question on the exam sheets.

1. Convert 1111_2 to its base ten equivalent using the template method
Answer:

				1	1	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

THE BINARY TEMPLATE

8+4+2+1=15.
Therefore, the base 10 equivalent is 15.

2. Convert 79_{10} to its binary equivalent using either the template method or long-division method.
Answer
(1) Template Method

	1	0	0	1	1	1	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
(128)	(64)	(32)	(16)	(8)	(4)	(2)	(1)

THE BINARY TEMPLATE

79 - 64 = 15 à 1 at P(64)
15 < 32   à 0 at P(32)
15 < 16   à 0 at P (15)
15 - 8 = 7   à 1 at P(8)
 7 - 4 = 3   à 1 at P(4)
 3 - 2 = 1   à 1 at P(2)
        1   à 1 at P(1)
Thus, the binary number is 1001111

(2) Long-division method

divisor	dividend	remainder
2	(79)	1
2	(39)	1
2	(19)	1
2	(9)	1
2	(4)	0
2	(2)	0
2	(1)	1
	(0)	

The binary is the sequence of the remainder from the bottom to the top, therefore, the answer is 1001111

3. Carry out the binary addition of **10111$_2$** + **01001$_2$**? Keep your answer in binary format
Answer:

```
      11111  (carry-on)
      10111
   +  01001
---------------------------
      100000
```

4. Carry out the binary subtraction of **10111$_2$** - **01001$_2$**? Keep your answer in binary format
 Answer:

```
      01        (borrow)
      10111
    - 01001
------------------------
      01110
```

5. Carry out the binary multiplication of **110$_2$** x **101$_2$**? Keep your answer in binary format
Answer:

```
        110
     X  101
------------------
        110
        000
   +    110
----------------------
      11110
```

6. What is the decimal value of 465$_8$?
Answer:

465$_8$ = 4 x 8^2 + 6 x 8^1 + 5 x 8^0 = 256 + 48 + 5 = 309$_{10}$

7. What is the decimal value of character "B" in ASCII table? What is the binary number of "B"?
Answer:
Look up the ASCII table, the decimal number of upper case "B" is 66.
To obtain the binary number, using the long-division method

```
   2   (66)  0
   2   (33)  1
   2   (16)  0
   2   ( 8)  0
   2   ( 4)  0
   2   ( 2)  0
   2   ( 1)  1
       ( 0)
```

Thus, the binary number is 1000010

8. Use ASCII code to encode the string "ASCII" into a binary sequence. Note that each character corresponds to 8 bits in binary number.

Answer:

Find the decimal number first, then use long-division to find the binary number

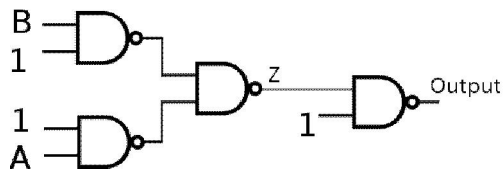   A   -> 65 ->1000001 -> 0100 0001
   S -> 83 ->1010011 -> 0101 0011
   C -> 67 ->1000011 -> 0100 0011
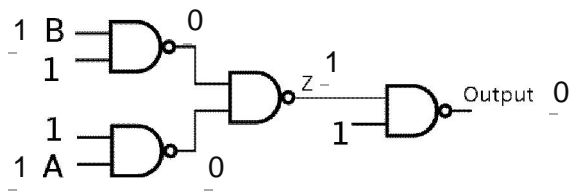   I -> 73 -> 1001001-> 0100 1001
   I -> 73 -> 1001001 -> 0100 1001

Therefore, the binary sequence of "ASCII" represented in a computer memory is
0100 0001 0101 0011 0100 0011 0100 1001 0100 1001

9. In the image below, four NANDS are connected and three of the inputs are set to 1. What are the values of Z and output if B = 1 and A = 0?
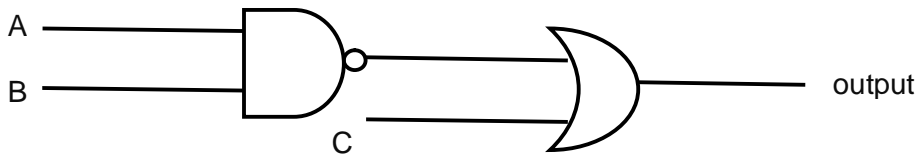

Answer:

Z = 1
output = 0

10. Fill out the logic table corresponding to the Logic Circuit shown below, which consists of a NAND gate and an OR gate. Show all input bit pattern combinations A, B and C in the table. For each input bit pattern combination, calculate the corresponding output.

A ─────────┐
) NAND ○──────────┐
B ─────────┘   ) OR ──────── output
)
           C ────────────────┘

A	B	C	Output
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	0
1	1	1	1

11. In a 7 bit analog to digital converter, how many different levels of data can be recorded?
Answer:
There are 2^7 different numbers that can be recorded. The answer is 128

12 For the matrix "A" shown below

12	4	5
1	7	6
32	23	9

(1) How many rows and columns in this matrix?
3 rows and 3 columns

(2) What is value of A(2,1)?
Row 2 Column 1 = 1

(3) What is value of A (1,3)?
Row 1 Column 3 = 5

(4) What is value of A(2,2)+A(3,1)?
Row 2 Column 2 = 7
Row 3 Column 1 = 32
7 + 32 = 39

12. Considering the following iteration code, what is A(4)?

```
A(1)=13;
for i=[2:4]
  A(i)=A(i-1)+37;
end
```

Answer:
      A(1) = 13
i=2   A(2) = A(1) + 37 = 13 + 37 = 50
i=3   A(3) = A(2) + 37 = 50 + 37 = 87
i=4   A(4) = A(3) + 37 = 87 + 37 = 124
Therefore, A(4) is 124

13. Considering the following iteration code, what is A after the FOR loop?

```
A(1)=0
for i=[1:5]
  A(i+1)=A(i)+i^2;
end
```

Answer:
      A(1) = 0
i=1   A(2) = A(1) +1^2= 0+1=1
i=2   A(3) = A(2) +2^2= 1+4=5
i=3   A(4) = A(3) +3^2= 5+9=14
i=4   A(5) = A(4) +4^2= 14+16=30
i=5   A(6) = A(5) +5^2= 30+25=55
Therefore, A will be a six element array of [0, 1, 5, 14, 30, 55]

The following statement is used for question 14, 15

My bank offers 5% interest on my account compounded yearly. Every year I deposit an additional $100. Assuming that on the first year your account had a balance of $100.

14. Translate the above statement into a mathematical model
Answer:
The mathematical model is
B(i+1) = B(i) + 0.05 x B(i) + 100

15.Translate your mathematical model into MATLAB programming code. Your code should be able to calculate the balance from year 1 to year 10. There is no need of doing the calculation in the exam. Only MATLAB code is needed.
Answer:

```
B(1) = 100;

for i=[2:10]
   B(i+1) = B(i) + 0.05*B(i) + 100;
end

B
```

Information Sheet

1. ASCII Table

Dec	Hx	Oct	Char		Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL	(null)	32	20	040	 	Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH	(start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX	(start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX	(end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT	(end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ	(enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK	(acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL	(bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS	(backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB	(horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF	(NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT	(vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF	(NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR	(carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO	(shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI	(shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE	(data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1	(device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2	(device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3	(device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4	(device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK	(negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN	(synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB	(end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN	(cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM	(end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB	(substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC	(escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS	(file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174	|		
29	1D	035	GS	(group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS	(record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US	(unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

Source: www.LookupTables.com

2. Logical Gates and Tables

AND

INPUT		OUTPUT
A	B	A AND B
0	0	0
0	1	0
1	0	0
1	1	1

OR

INPUT		OUTPUT
A	B	A OR B
0	0	0
0	1	1
1	0	1
1	1	1

NOT

INPUT	OUTPUT
A	NOT A
0	1
1	0

NAND

INPUT		OUTPUT
A	B	A NAND B
0	0	1
0	1	1
1	0	1
1	1	0

NOR

INPUT		OUTPUT
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0

XOR

INPUT		OUTPUT
A	B	A XOR B
0	0	0
0	1	1
1	0	1
1	1	0