CDS 130-003 Computing for Scientists

Midterm Exam Review

Oct. 21, 2010

Topics

Session 1: Fundamentals
CH1: Binary Representation
- Binary to decimal conversion: power method
- Decimal to binary conversion: long division method

CH2: Data Storage
- Data density
- Bits and bytes
- ASCII table, encoding

CH3: Logic Circuits and Logic Tables
- Transistor: the building block
- AND gate, AND table; OR gate, OR table; NOT gate, NOT table
- NAND gate, NAND table
- XOR (EOR) gate, XOR table
- Adding binary number

Session 2: Measurements
CH1: Sensors
- Electric measurement
- CCD (Charge Coupled Device)

CH2: Sensor Limitations
- Lower limit and upper limit
- Resolutions: Time, Space, and Level
- ADC: Analog to Digital Converter
- Signal, noise and background
- Signal to Noise Ration (SNR)

Session 3: Scientific Simulation
CH1: Mathematical model
- Scientific model to mathematic model

CH2: Numerical method
- Iteration
- Differential equation
- Interval and sub-interval
- Integration
- Integration accuracy and size of sub-interval (or number of iteration)

CH3: Verification and Validation
- Scientific method: characterization, hypothesis, prediction and testing

This is a close-book exam. Calculator is allowed. Your answer should be given in the exam papers immediately following the questions.

1. Binary-to-decimal
Convert 00111 to decimal?

2. Decimal-to-binary
Convert 49 to binary?

3. ASCII table
What is the decimal number of character "B" in ASCII table? What is the binary number of "B"?

4. Logic Gates and Logic Tables
In the image below, four NANDS are connected and three of the inputs are set to 1. What are the values of Z if B = 1 and A = 0? For reference, the logic table associated with a NAND gate is shown.

A.   Z=0, output=0
B.   Z=0, output=1
C.   Z=1, output=0
D: Z=1, output=1
E: can not be determined
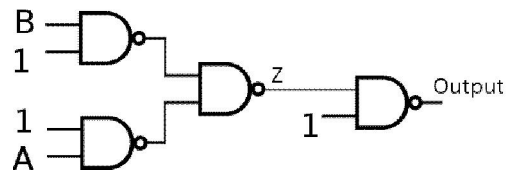
5. Sensor: Analog to Digital Converter
In a 7 bit analog to digital converter, how many different levels of data can be recorded?

A. 7
B. 70
C. 128
D. 256
E. 1024

6. Sensor: resolution
A scientific temperature sensors has an operational range between -200 and 200 degree in Fahrenheit, and use 12 bits to convert the data. What is the temperature resolution of the detector?

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

```
A(9)=13;
for i=[10:12]
  A(i)=A(i-1)+37;
end
```

The following statement is used for question 8, 9, 10, 11

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.

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8. Scientific Model to Mathematical Model
Translate the above statement into a mathematical representation

9. Mathematical Model to Computational Model
Translate your mathematical representation into Matlab/Octave code that uses iteration to specify your balance after 10 years.

10. Interval and sub-interval
When you are asked to calculate the balance for the next 10 years on a yearly basis. What is the interval and sub-interval of the calculation?

11. What is the balance in the 4th year?

12. Differentiation equation
Translate the following differential equation into the iteration mathematical representation

$$\frac{dP}{dt} = 0.5 \times P$$

13. Integration

$$f(x) = x$$

$$F = \int_0^{4.0} x\,dx$$

Consider the integration of the function, f(x)=x, from the interval of x=0 to x=4.0. You are asked to make a numerical approximation of this integration using the area method, that is to find the geometric area underneath the function with the sum of a series of rectangles.
If you choose the sub-interval x=1.0, what is the approximated area?

14. If the sub-interval is chosen to be x=0.1, do you think that you will get a different value of the numerical integration? Explain why?

15. Validation: scientific method
Describe in a few sentences in your word what is a scientific method?

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. NAND gate and its logic table

NAND gate
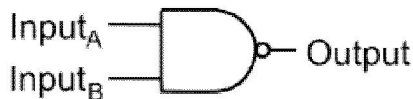
Input A	Input B	Output
0	0	1
0	1	1
1	0	1
1	1	0