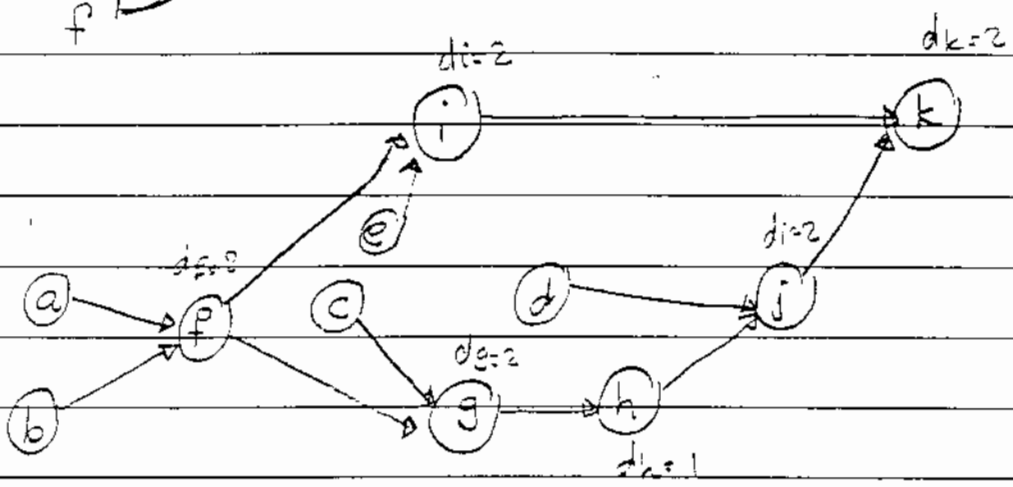
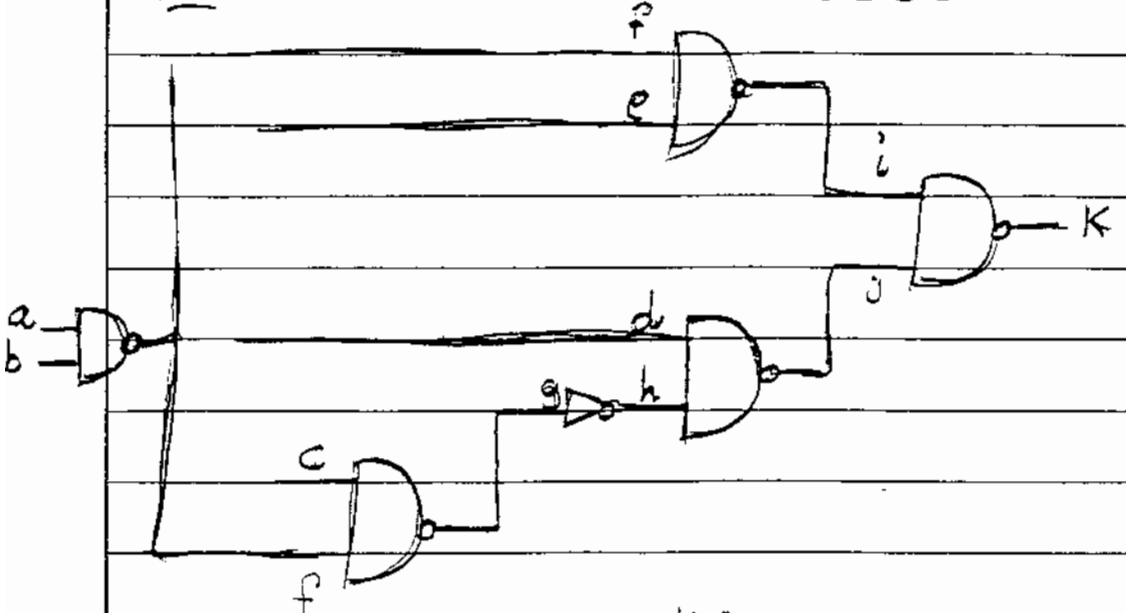


Q1 (L)

HW#5

COE 561
Dr. El-Malch



data ready time	Data required time	Slack
$t_a = 2$	$\bar{t}_k = 11$	$S_a = 2 - 2 = 0$
$t_b = 0$	$\bar{t}_j = 11 - 2 = 9$	$S_b = 2 - 0 - 2$
$t_c = 0$	$t_i = 11 - 2 = 9$	$S_c = 4 - 0 = 4$
$t_d = 0$	$\bar{t}_h = 9 - 2 = 7$	$S_d = 7 - 0 - 7$
$t_e = 0$	$\bar{t}_g = 7 - 1 = 6$	$S_e = 7 - 0 = 7$
$t_f = 2 + 2 = 4$	$\bar{t}_p = 6 - 2 = 4$	$S_f = 4 - 4 = 0$
$t_g = 6 + 0 = 6$	$\bar{t}_e = 9 - 2 = 7$	$S_g = 6 - 6 = 0$
$t_h = 6 + 1 = 7$	$\bar{t}_d = 9 - 2 = 7$	$S_h = 7 - 7 = 0$
$t_i = 6 + 2 = 8$	$\bar{t}_c = 6 - 2 = 4$	$S_i = 9 - 6 = 3$
$t_j = 7 + 2 = 9$	$\bar{t}_b = 4 - 2 = 2$	$S_j = 9 - 9 = 0$
$t_k = 9 + 2 = 11$	$\bar{t}_a = 4 - 2 = 2$	$S_k = 11 - 11 = 0$

Q1

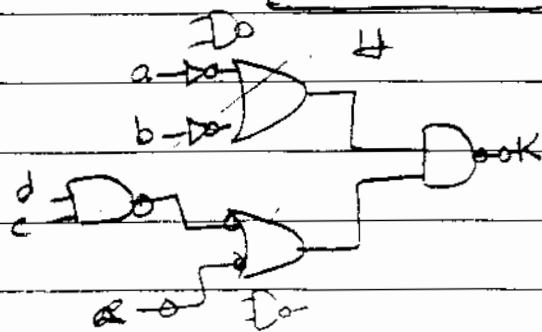
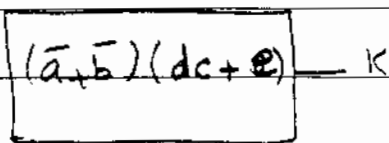
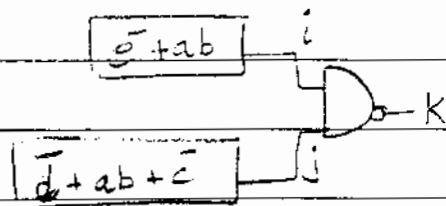
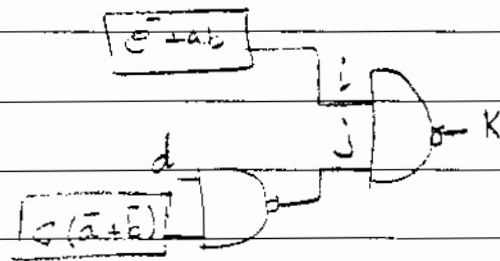
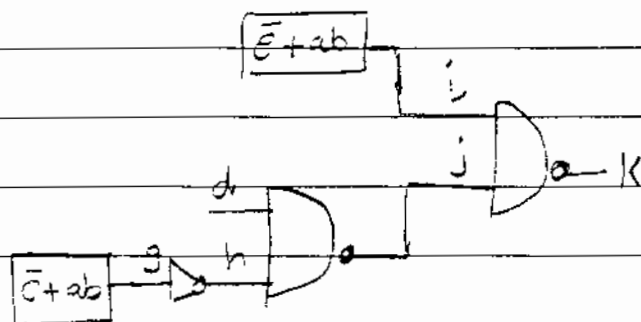
(ii) Input/output Path with zero slack

a, f, g, k, j, k

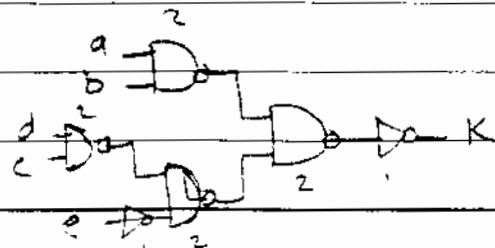
Q1

(iii) * select vertex k, let $d=5$

* using elimination



Area reduced
10 literals < 11



Worst case delay = 7 < 11

Q2

(i)

$$F = ab + \bar{b}c$$

\Rightarrow permutations = $3!$ (initially)

First:

* unate variables = 2

Unateness Filter

* binate variables = 1

\Rightarrow Unateness filter will reduce the # of permutation to $(2! \times 1!)$: 2

Second

symmetric Filter

* symmetric classes = 0

\Rightarrow no reduction due to symmetric filters.

(ii)

$$F = ab + cd$$

\Rightarrow permutations = $4!$ (initially)

First: unateness Filter

* unate variables = 4

* binate " = 0

\Rightarrow no reduction

second symmetric filters:

$$(ab), (cd) \quad |C_2| = 2$$

\Rightarrow # permutations reduced to $2!$: 2

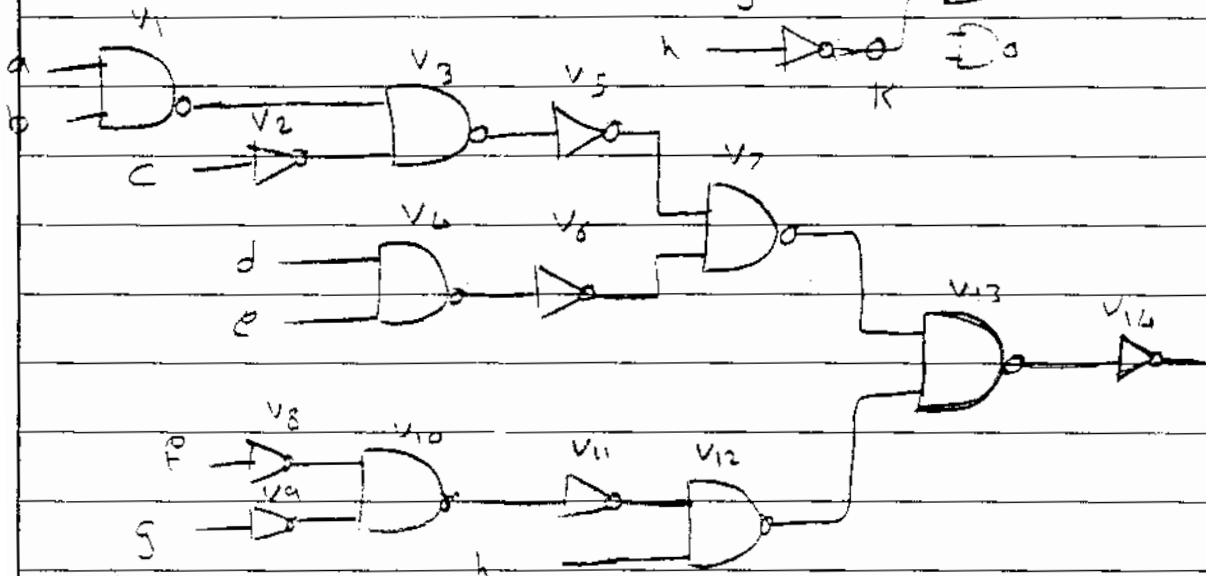
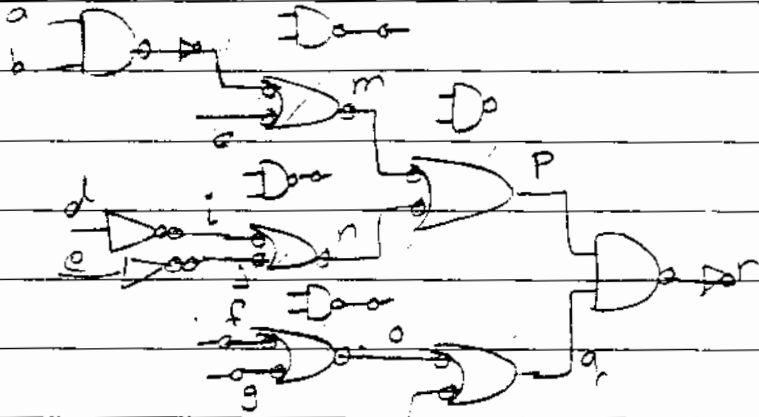
(iii)

same as part (ii)

of ROBOP's = 2

Q.3

(i)

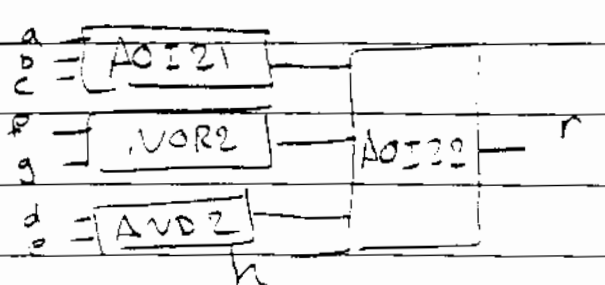


(ii)

using the following table

ID	Cell	Implementation	cost
t ₁	INV		1
t ₂	NAND2		2
t ₃	AND2		2.5
t ₄	NOR2		2
t ₅	OR2		2.5
t ₆	AOI21		4
t ₇	AOI22		4.5

vertex	match	gate	cost
v_1	t_2	NAND 2(a,b)	2
v_2	t_1	INV(c)	1
v_3	t_2	NAND2(v_1, v_2)	$2+1+2 = 5$
v_4	t_2	NAND2(d,e)	2
v_5	t_1	INV(v_3)	$5+1 = 6$
	t_2	AND2(v_1, v_2)	$2+1+2.5 = 5.5$
	t_5	AOT 21(a,b,c)	4
v_6	t_1	INV(v_4)	$2+1 = 3$
	t_3	AND2(d,e)	2.5
v_7	t_2	NAND2(v_5, v_6)	$6+2.5+2 = 8.5$
	t_5	OR 2(v_3, v_4)	$5+2+2.5 = 9.5$
v_8	t_1	INV(e)	1
v_9	t_1	INV(g)	1
v_{10}	t_2	NAND2(v_8, v_9)	$1+1+2 = 4$
	t_5	XOR 2(f,g)	2.5
v_{11}	t_1	INV(v_{10})	$2.5+1 = 3.5$
	t_3	AND2(v_8, v_9)	$1+1+2.5 = 6.5$
	t_2	NOR 2(f,g)	2
v_{12}	t_5	NAND2(v_{11}, h)	$2+2 = 4$
v_{13}	t_2	NAND2(v_7, v_{12})	$8.5+4+2 = 14.5$
v_{14}	t_1	INV(v_{13})	$= 14.5+1 = 15.5$
	t_3	AND(v_7, v_{12})	$= 8.5+4+2.5 = 15$
	t_7	AOT 22(v_5, v_6, v_{11}, h)	$4+2.5+2+6.5 = 13$



```

login as: sakhras
Password:
Last login: Tue Nov 15 02:53:19 2005 from linux.ccse.kfup
Sun Microsystems Inc. SunOS 5.9 Generic May 2002
You have mail.
sunfire3>
sunfire3> sis
UC Berkeley, SIS Development Version (compiled 27-Sep-99 at 11:08 AM)
sis> read library hw5051.lib
sis> read_eqn hw5051.eq
sis> print
(r) = p q
i = d'
j = e'
k = h'
l = a b
m = c + l
n = i + j
o = f + g
p = m + n
q = k + o
sis> map -s -m 0
WARNING: uses as primary input drive the value (0.20,0.20)
WARNING: uses as primary input arrival the value (0.00,0.00)
WARNING: uses as primary input max load limit the value (999.00)
WARNING: uses as primary output required the value (0.00,0.00)
WARNING: uses as primary output load the value 1.00
>>> before removing serial inverters <<<
# of outputs: 1
total gate area: 13.00
maximum arrival time: (2.60,2.60)
maximum po slack: (-2.60,-2.60)
minimum po slack: (-2.60,-2.60)
total neg slack: (-2.60,-2.60)
# of failing outputs: 1
>>> before removing parallel inverters <<<
# of outputs: 1
total gate area: 13.00
maximum arrival time: (2.60,2.60)
maximum po slack: (-2.60,-2.60)
minimum po slack: (-2.60,-2.60)
total neg slack: (-2.60,-2.60)
# of failing outputs: 1
# of outputs: 1
total gate area: 13.00
maximum arrival time: (2.60,2.60)
maximum po slack: (-2.60,-2.60)
minimum po slack: (-2.60,-2.60)
total neg slack: (-2.60,-2.60)
# of failing outputs: 1
sis> write blif -n
.model hw5051.eq
.inputs a b c d e f g h
.outputs r
.default_input_arrival 0.00 0.00
.default_output_required 0.00 0.00
.default_input_drive 0.20 0.20
.default_output_load 1.00
.default_max_input_load 999.00
.gate AOI21 a=c b=a c=b O=m
.gate AND2 a=d b=e O=n
.gate NOR2 a=f b=g O=o
.gate AOI22 a=m b=n c=h d=o O=r
.end
sis> print
m = a' c' + b' c'
n = d e
o = f' g'
(r) = h' m' + h' n' + m' o' + n' o'
sis> quit
sunfire3> ^A

```

* Comparison:

- Total gate area is Area = 13 as got in part 2
- The same numbers obtained in 2