

Map Layout

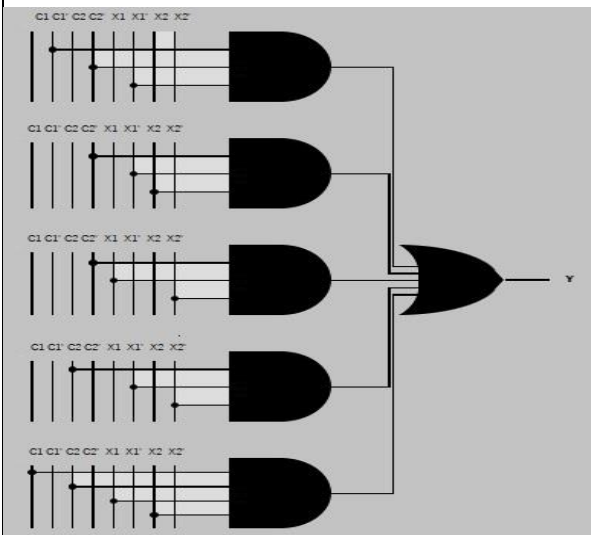
	X1'X2'	X1'X2	X1X2	X1X2'
C1'C2'	0	1	3	2
C1'C2	4	5	7	6
C1C2	12	13	15	14
C1C2'	8	9	11	10

Groups

(0,1)	C1'C2'X2
(1,9)	C1'X1'X2
(2,10)	C1'X1X2'
(4,12)	C2X1'X2'
(15)	C1C2X1X2

$$Y = C1'C2'X2 + C1'X1'X2 + C1'X1X2' + C2X1'X2' + C1C2X1X2$$

Implementation using NAND gate



<http://www.32x8.com/var4.html>

2 A Digital system is to be designed in which month of the year is given as input is four bit form. The month January is represented as "0000", February as "0001" and so on. The output of the system is 1 corresponding to the input of the month containing 31 days or otherwise is 0 consider excess number in the input beyond '1011' as don't cares conditions.

- Write truth table ,SOP
- Simplify for SOP using **QM method**
- Realize using Basic Gates

Solution :

Input	First Comparison	Second Comparison
0 m0 0000	(2, 0) 00-0 (4, 0) 0-00	(6, 4, 2, 0) 0-0
1 m2 0010 m4 0100	(6, 2) 0-10 (6, 4) 01-0 (12, 4) -100	(14, 12, 6, 4) -1-0
2 m6 0110 m9 1001 d12 1100	(7, 6) 011- (14, 6) -110 (11, 9) 10-1 (13, 9) 1-01 (13, 12) 110- (14, 12) 11-0	(15, 14, 7, 6) -11- (15, 13, 11, 9) 1-1- (15, 14, 13, 12) 11-
3 m7 0111 m11 1011 d13 1101 d14 1110	(15, 7) -111 (15, 11) 1-11 (15, 13) 11-1 (15, 14) 111-	
4 d15 1111		

[10]

CO2

L2,L3

Prime Implicants

0	1	2	3	4	5
6	7	8	9	10	11
12	13	14	15	16	17
18	19	20	21	22	23
24	25	26	27	28	29
30	31	32	33	34	35
36	37	38	39	40	41
42	43	44	45	46	47
48	49	50	51	52	53
54	55	56	57	58	59
60	61	62	63	64	65
66	67	68	69	70	71
72	73	74	75	76	77
78	79	80	81	82	83
84	85	86	87	88	89
90	91	92	93	94	95
96	97	98	99	100	101
102	103	104	105	106	107
108	109	110	111	112	113
114	115	116	117	118	119
120	121	122	123	124	125
126	127	128	129	130	131
132	133	134	135	136	137
138	139	140	141	142	143
144	145	146	147	148	149
150	151	152	153	154	155
156	157	158	159	160	161
162	163	164	165	166	167
168	169	170	171	172	173
174	175	176	177	178	179
180	181	182	183	184	185
186	187	188	189	190	191
192	193	194	195	196	197
198	199	200	201	202	203
204	205	206	207	208	209
210	211	212	213	214	215
216	217	218	219	220	221
222	223	224	225	226	227
228	229	230	231	232	233
234	235	236	237	238	239
240	241	242	243	244	245
246	247	248	249	250	251
252	253	254	255	256	257
258	259	260	261	262	263
264	265	266	267	268	269
270	271	272	273	274	275
276	277	278	279	280	281
282	283	284	285	286	287
288	289	290	291	292	293
294	295	296	297	298	299
300	301	302	303	304	305
306	307	308	309	310	311
312	313	314	315	316	317
318	319	320	321	322	323
324	325	326	327	328	329
330	331	332	333	334	335
336	337	338	339	340	341
342	343	344	345	346	347
348	349	350	351	352	353
354	355	356	357	358	359
360	361	362	363	364	365
366	367	368	369	370	371
372	373	374	375	376	377
378	379	380	381	382	383
384	385	386	387	388	389
390	391	392	393	394	395
396	397	398	399	400	401
402	403	404	405	406	407
408	409	410	411	412	413
414	415	416	417	418	419
420	421	422	423	424	425
426	427	428	429	430	431
432	433	434	435	436	437
438	439	440	441	442	443
444	445	446	447	448	449
450	451	452	453	454	455
456	457	458	459	460	461
462	463	464	465	466	467
468	469	470	471	472	473
474	475	476	477	478	479
480	481	482	483	484	485
486	487	488	489	490	491
492	493	494	495	496	497
498	499	500	501	502	503
504	505	506	507	508	509
510	511	512	513	514	515
516	517	518	519	520	521
522	523	524	525	526	527
528	529	530	531	532	533
534	535	536	537	538	539
540	541	542	543	544	545
546	547	548	549	550	551
552	553	554	555	556	557
558	559	560	561	562	563
564	565	566	567	568	569
570	571	572	573	574	575
576	577	578	579	580	581
582	583	584	585	586	587
588	589	590	591	592	593
594	595	596	597	598	599
600	601	602	603	604	605
606	607	608	609	610	611
612	613	614	615	616	617
618	619	620	621	622	623
624	625	626	627	628	629
630	631	632	633	634	635
636	637	638	639	640	641
642	643	644	645	646	647
648	649	650	651	652	653
654	655	656	657	658	659
660	661	662	663	664	665
666	667	668	669	670	671
672	673	674	675	676	677
678	679	680	681	682	683
684	685	686	687	688	689
690	691	692	693	694	695
696	697	698	699	700	701
702	703	704	705	706	707
708	709	710	711	712	713
714	715	716	717	718	719
720	721	722	723	724	725
726	727	728	729	730	731
732	733	734	735	736	737
738	739	740	741	742	743
744	745	746	747	748	749
750	751	752	753	754	755
756	757	758	759	760	761
762	763	764	765	766	767
768	769	770	771	772	773
774	775	776	777	778	779
780	781	782	783	784	785
786	787	788	789	790	791
792	793	794	795	796	797
798	799	800	801	802	803
804	805	806	807	808	809
810	811	812	813	814	815
816	817	818	819	820	821
822	823	824	825	826	827
828	829	830	831	832	833
834	835	836	837	838	839
840	841	842	843	844	845
846	847	848	849	850	851
852	853	854	855	856	857
858	859	860	861	862	863
864	865	866	867	868	869
870	871	872	873	874	875
876	877	878	879	880	881
882	883	884	885	886	887
888	889	890	891	892	893
894	895	896	897	898	899
900	901	902	903	904	905
906	907	908	909	910	911
912	913	914	915	916	917
918	919	920	921	922	923
924	925	926	927	928	929
930	931	932	933	934	935
936	937	938	939	940	941
942	943	944	945	946	947
948	949	950	951	952	953
954	955	956	957	958	959
960	961	962	963	964	965
966	967	968	969	970	971
972	973	974	975	976	977
978	979	980	981	982	983
984	985	986	987	988	989
990	991	992	993	994	995
996	997	998	999	1000	1001

Coverage Table

	0-0	1-0	1-1	1-1	1-1
0	x				
2	x				
4	x	x			
6	x	x	x		
7			x		
9				x	
11				x	

Essential Prime Implicants
Using column/row dominance methods.
Tutorial 6
 $AB + BC + AD$

<http://quinemccluskey.com/?min=0%0D%0A2%0D%0A4%0D%0A6+%0D%0A7%0D%0A9%0D%0A11&dont=>

3 (a) Define 1.Implicant 2.Prime Implicant 3.Essential Prime Implicant 4. Selective prime implicant 5.Redundant prime implicant
Solution:

[05] CO2 L1,L2

(b) Design function EX OR gate 1) using NAND gate only 2) using NOR gate only

(e) Ex-OR gate: $Y = A \oplus B$

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(e) Ex-NOR gate: $Y = A \odot B = (A \oplus B)'$

0	0	1
0	1	0
1	0	0
1	1	1

[05] CO2 L1,L2

4(a) Using the method of map-entered variables, use four-variable maps to find a minimum sum-of-products expression for $F(A, B, C, D, E) = m(0, 2, 5, 8, 9) + d(6, 10) + E(m7, m12)$ where the m 's represent minterms of the variables $A, B, C,$ and D .

Truth Table

	A	B	C	D	Y
0	0	0	0	0	1
1	0	0	0	1	0
2	0	0	1	0	1
3	0	0	1	1	0
4	0	1	0	0	0
5	0	1	0	1	1
6	0	1	1	0	X
7	0	1	1	1	E
8	1	0	0	0	1
9	1	0	0	1	1
10	1	0	1	0	X
11	1	0	1	1	0
12	1	1	0	0	E
13	1	1	0	1	0
14	1	1	1	0	0
15	1	1	1	1	0

Map

	C'D'	C'D	CD	CD'
A'B'	1	0	0	1
A'B	1	1	E	X
AB	E	0	0	0
AB'	1	1	0	X

Map Layout

	C'D'	C'D	CD	CD'
A'B'	0	1	3	2
A'B	4	5	7	6
AB	12	13	15	14
AB'	8	9	11	10

Step 1 : consider 1s and don't cares and E=0

	C'D'	C'D	CD	CD'
A'B'	1	0	0	1

[06]

CO2

L2,L3

A'B	1	1	0	X
AB	0	0	0	0
AB'	1	1	0	X

Groups

(0,2,8,10)	B'D'
(8,9)	AB'C'
(5)	ABC'D

SO $MS1=B'D'+AB'C'+ABC'D$

STEP 2 : consider variable E = 1 and make all 1s don't care and consider all don't care

	C'D'	C'D	CD	CD'
A'B'	X	0	0	X
A'B	X	X	1	X
AB	1	0	0	0
AB'	X	X	0	X

Groups

(5,7)	A'BD
(8,12)	AC'D'

SO $MS2=(A'BD+AC'D')E =A'BDE+AC'D'E$

SO minimum SOP Boolean expression is $=MS1+MS2= B'D'+AB'C'+ABC'D+ A'BDE +AC'D'E$

4(b) What are the benefits of MEV over KM Method.

Solution:

K-map is the best manual technique to solve Boolean equations, but it becomes difficult to manage when number of variables exceed 5 or 6. So, a technique called Variable Entrant Map (VEM) is used to increase the effective size of k-map. It allows a smaller map to handle large number of variables. This is done by writing output in terms of input.

[04]

CO2

L1,L2

5 Consider the following logic function.

$F(A, B, C, D)=m(0, 4, 5, 10, 11, 13, 14, 15)$

(a) Find two different minimum circuits which implement F using AND and OR gates.

Identify two hazards in each circuit

(b) Find an AND-OR circuit for F which has no hazards.(hazard cover)

(c) Find an OR-AND circuit for F which has no hazards. (hazard cover)

Solution :

(a)

Map

	C'D'	C'D	C.D	C.D'
A'B'	1	0	0	0
A'B	1	1	0	0
A.B	0	1	1	1
AB'	0	0	1	1

Map Layout

	C'D'	C'D	C.D	C.D'
--	------	-----	-----	------

[10]

CO2

L3,L2

A'B'	0	1	3	2
A'B	4	5	7	6
A.B	12	13	15	14
AB'	8	9	11	10

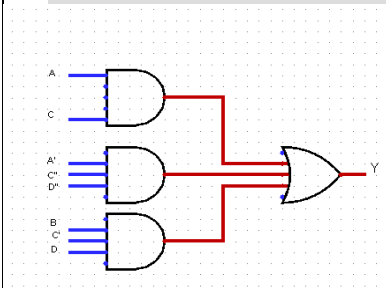
Groups

(10,11,14,15)	A.C	
(0,4)	A'.C'.D'	
(5,13)	B.C'.D	
(4,5)	A'BD	STATIC-1 COVER
(15,13)	ABD	STATIC-1 COVER

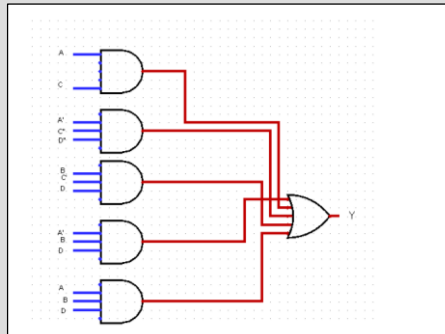
Minimize SOP expression $Y = AC + A'C'D' + BC'D$

Implement using AND-OR circuit as follows

1.



2.



(b) Recover Static -1 in SOP are $= AC + A'C'D' + BC'D + A'BD + ABD$

2.

(a) PRODUCT of SUMS

Map

	C'D'	C'D	C.D	C.D'
A'B'	1	0	0	0
A'B	1	1	0	0
A.B	0	1	1	1
AB'	0	0	1	1

Map Layout

	C'D'	C'D	C.D	C.D'
A'B'	0	1	3	2
A'B	4	5	7	6
A.B	12	13	15	14
AB'	8	9	11	10

Groups

(2,3,6,7)	A.C
-----------	-----

(1,9)	$B'.C'.D$
(8,12)	$A.C'.D'$

$$y = A.C + B'.C'.D + A.C'.D'$$

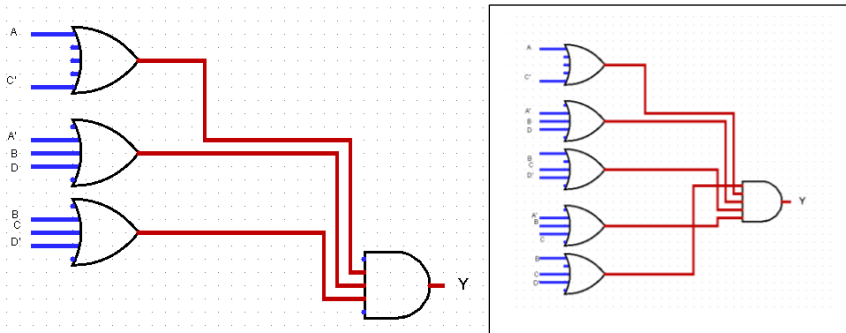
$$y = A.C + B'.C'.D + A.C'.D'$$

Minimize POS expression $Y = (A + C') (B + C + D') (A' + C + D)$

Implement using OR-AND circuit as follows

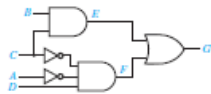
1.

2.



2.Recover Static -1 in POS are $(A + C') (B + C + D') (A' + C + D)(A' + B + C)(B + C + D')$

6 What is the use of simulation software? For the following circuit
 (a) Assume that the inverters have a delay of 1 ns and the other gates have a delay of 2 ns. Initially $A = 0$ and $B = C = D = 1$, and C changes to 0 at time =2 ns. Draw a timing diagram and identify the transient that occurs.

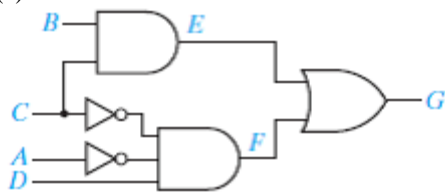


(b) Modify the circuit to eliminate the hazard.

Solution :

Simulation is a decision analysis and support tool. Simulation software allows you to evaluate, compare and optimize alternative designs, plans and policies

(a)



[5+5]

CO2

L1,L2,L3

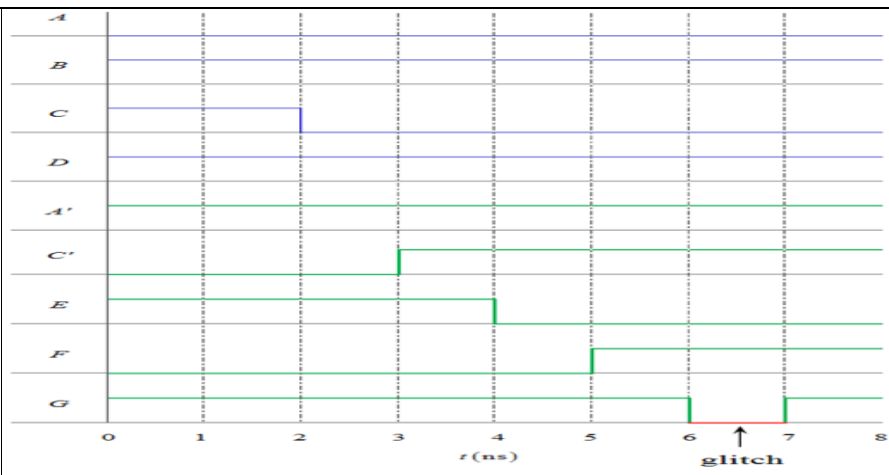


Figure 1

(b) Recover Hazard circuit as below

