2301-COL215 Mid-term_Exam

Akshat Jha

TOTAL POINTS

56 / 60

QUESTION 1

Minimum logic area circuit 10 pts

1.1 Karnaugh Map 5 / 5

 \checkmark + **5 pts** Correct answer and pointing use of 2 K-maps

- + 3 pts partially correct
- + 0 pts Wrong or not answered

1.2 Disadvantages of K Map 3 / 5

- **+ 5 pts** Correctly pointing, miss out on optimising across the two boolean functions
- √ + 3 pts partially correct
 - + 2 pts some valid point
 - + 0 pts wrong

QUESTION 2

2 Ripple carry adder 10 / 10

 \checkmark + 10 pts Correct : 3n + max(m, n)

+ 8 pts Partial: 3n + m

+ 5 pts Partial: 4n

+ 0 pts Incorrect/Not Attempted

QUESTION 3

3 Encoder 10 / 10

- √ + 4 pts Truth Table
- √ + 6 pts Explanation
 - + 0 pts Answer not correct

OUESTION 4

4 VHDL model 8 / 10

- + 0 pts Incorrect/Unattempted
- √ + 8 pts Correct Idea, Incorrect implementation
 - + 10 pts Correct
- + **5 pts** Correct direction, Missing proper definitions
 - Variables cannot be declared without process.

QUESTION 5

5 CMOS circuit 10 / 10

- √ + 10 pts Fully correct
 - + 0 pts Incorrect
 - + **5 pts** Click here to replace this description.
 - + 7.5 pts Click here to replace this description.
 - + 2.5 pts Click here to replace this description.

QUESTION 6

6 Martian Number system 10 / 10

- √ + 10 pts Correct
- + 7.5 pts Calculation mistake in solving the final equation
- + 7.5 pts Couldn't arrive at a single solution or Didn't check consistency of equations or Didn't explain the reason for rejecting a solution
 - + **5 pts** Partly Correct
 - + 0 pts Incorrect/Unattemted

An alternative approach sould be using a MUX implementation. With n output functions and minpuls, we can create a not to I MUX with [1092 n7 gulects and we then need to optimize each function indiduction (K-mep (Though, this would the MUXand pass it through reduction) four worse) of At Wart of Walt of the

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I Semester 2023-24, Mid-semester Exam, Maximum Marks: 60, 26 Sep 2023, 3:30 PM to 5:00 PM Please write your answers ONLY IN THE SPACE BELOW THE QUESTIONS

Use reverse side of paper for rough work.

1. [5+5=10 Marks] Suppose we wish to design a minimum-area logic circuit implementing a multi-Minimum area & tewer output boolean function (e.g., the circuit has 4 inputs and 2 outputs). transistors. Suggest how we can use Karnaugh Maps (K-Maps) to achieve this objective. he can the common minterms out of all the k-maps (implicants). Once we gather these minterms (common implicants), we group them using K-map rules. This algorithm can be implemented using a greedy approach. Now the common implicants (now, maybe reduced) can be connected with the uncommon once in the CMOS implementation and this appropriatelyaling would gurantee that fewer transistors one used => lesser area is requir on an individual we level, we ensure to Enclude prime implicants

b. Point out a disadvantage of minimising the multi-output function using the K-Map approach. A lot of interconnections he would be required in this approach. Hence the delays (time) to complete computation would be large. Another problem might be when the number of input variables increases as K-map solutions become incremingly consplex and on top of that mereducing the common implicants would relative many steps too-

of each output function to reduce # transistors there as well.

2. [10 Marks] Consider the 4-bit ripple carry adder discussed in class. Suppose the SUM bit in a one-bit full adder stabilises after m nano-seconds, and the CARRY OUT bit stabilises after nnano-seconds. What is the delay of the 4-bit adder? Justify your answer.

>Courl

T(a) = Time to get signal a. We can see that T(si)= T(ci=)+m

T (ci) = T(ci) + man assuming the relevant x, y are - ready.

Solving this recurrence gives us T(co)=0 ("Ready") T(c4)=4n

T(So) = m T(c1)=n

The max delay out of the SUM BITS is CARRY 15175 I'S 412

T(S1) = man

Hence, the delyay of the 4 bit adder

T(S2)= 2n

83n+M, 4n3 is max

3n+max 3m,n3

T(sa)= 2n+m

T (c3)=3n T (53)= 3 n+m If the cour is & discarded,

delay is 30+m

D3 XY V Here is the full table showing all possible table rows. Note how we can The state of abub rows together into ky - R5. O O P P2 OND TOWN OF D. AND OF D. DED. 9 = DO AND DA AND OR DZ OKDZ 0 0 0 0 (01113 X= D2 OK D5 1000101 ANT PAHERA 0 0 4 = D3 OR 0000 (D, and 52) 101 0 1 0 obtained from K-Map minimization 10101 over this table achieves the desired output. 101 11 In R, x andy get o value which is fine since the - 21 ad 21 Sec. 814 care of which values promote the short has also a few on the ingramulated outside and depte outs Logisamon and pas (Laurden adjuster, form) there is a service and the street of the production and the service make to a form the former thanker and some trades of residence and animaliar chestiform and shape to proper on the same of he The same and the same of the same of the same to be the same of th country - Linders again again of the super and allower and reconstitution or again to tal in the delays laters to complete conspicting whether against a factors of the part of the same of the sam sure to any the statement the second to the statement of the second seco IN TEST THE THE THEORY LINE MANNEY WITHOUT SALES FOR on temper the or amile Coll TARY THE MIND BY maining right OME CHANGE = GOTT the tarty amornizate that last littles partenant men parental subjecting to pur-Trans Pressy's Trees in

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3. [10 Marks] In the Priority Encoder we discussed in class, the output was derived from input by just OR-ing the appropriate input variables. Why is this valid, considering that only a subset of table rows were listed in the truth-table? Explain.

D. D. D. D. XY V
RIO O O O O XX O
RL 1 O O O O O I
R3 X I O O O I I
R4 X X I O I O I
R5 X X X X I I I I I

consider a 4-bit priority encoder. 24 bit-vectors are possible.

RI - 1 entry. R2 - 1 entry.

R3 -> 2' possible values (1x)

R4 -> 2²-4 (2x's) R6 -> 2³-8

[3x's)

In total we do get 16 rows had we enumerated the cases separately.

In any one of the R6 rows, for example, all 4 such table rows would result in (1,1,1) as outputs so just taking into consideration one row with the characteristic that D3=1 and others "unknown would made the bunchion's behaviour (consider the full table in the adjoining pare)

 [10 Marks] Write a VHDL model with the following behaviour: When simulated, the simulation fails to proceed beyond 10 nanoseconds.

ENTITY Stopper is PORT (6: IN BIT; d: OUT BIT)

EWD Stopper;

ARCHITECTURE Stop of stopper 15

VARIABLE a: BIT := '1';

BEGIN after 10 ns;

END stop;

d (0,10) lons

Event 200, 10) is executed and then intinite deltas of alternative values of '0' and '1' for a ase created that stop the simulation at 10 ns Delta 1 Delta 2 Delta 3 acr acr acr be 1 be 0 be 1

The deltas don't stabilize

Consider a 4-44 pintin enader,

2 hr-vectors are possible

24 tenny, 164 represent

25 - 2' yessibit value (1x)

24 (1x's) 86 - 2'-2

25 tenad we are get 16 reads

30 we enamerated the cutch

30 we enamerated the cutch

30 separately.

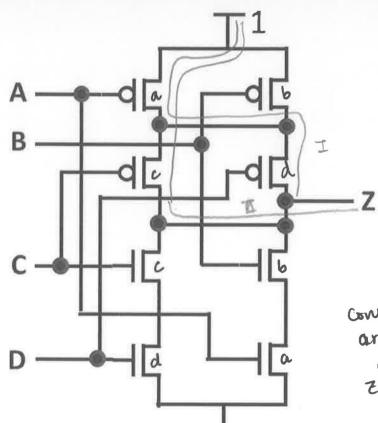
In any one of the tile to the example, all 4 buch lather rever would retail in [1], it is only all so just having the considerable one rever when the considerable that the fig. one others "unknown one read where "unknown result would have become the finite for the function of behaviors." I consider the latter of the adjunction of the adjunction of the adjunction of the adjunction.

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5. [10 Marks] What function of A, B, C, and D does the following CMOS transistor circuit implement? Justify. [Note that crossing wires are connected only when there is a black circle at the intersection]



looking at the NMOS part,

Z is connected to ground and hence'o'

or a and b are low

This gives us

= ab+cd

or = ab+cd

We can look at the PMOS part nou,

Consider path I, both PMOS

are actrivated when a

and d are low and

Z gets connected to '1'.

i.e.a'Bd' gives a

manterm of 2.

Similarly, Z gets '1' when

a and c are both low \Rightarrow a'c'

Using all possible 'low' combinations, Z = a'c'+ a'd'+ b'd'+ b'c'

Look to supe the publical of ballatings in & BANKER ond henvelo DON'TE e and a age Hill be a and b are low this gird us soft to wood has the compider putit I. Don prous a markly british your man have been size to have Tara and a star of the contraction of wante "I" step 3 grangered own one my allow a "boay" allyickey "ad + "b" of the to + "b" on the contractions Habita (40) 2 Canada (manga) + rd tab

6. [10 Marks] The first manned expedition to Mars ("Mangalyaan") found only the ruins of a civilization. From the artifacts and pictures, the explorers deduced that the creatures who produced this civilization were four-legged beings with a tentacle that branched out at the end with a number of grasping "fingers." After much study, the explorers were able to translate Martian mathematics. They found the following equation: $5x^2 - 50 x + 125 = 0$ with the indicated solutions x = 5 and x = 8. The value x = 5 seemed legitimate enough, but x = 8 required some explanation. Then the explorers reflected on the way in which Earth's number system developed, and found evidence that the Martian system had a similar history. How many fingers would you say the Martians had? Justify. (From The Bent of Tau Beta Pi, February 1956. Extracted from Wakerly, Digital Design) [Hint: the number of fingers relates to number representation the same way it does for humans.]

tet the Martian system have bose b: (5)=5 = # finyers (50)=5b+0=5b $(125)=1(b^2)+2(b)+5$

 $5 \times 2 = 5b \times + b^{2} + 2b + 5 = 0$ in 6 and 8 are solutions $b \times 1$ this quadratic in b. $6^{2} + b(2 = 5 \times) + (5 + 5 \times^{2}) = 0$ $6 \times 3 + 8 = -(2 + 5 \times)$ and $6 \times 8 = 5 + 3 \times^{2} \Rightarrow \times^{2} + 1 = 8$ and $7 \times 8 = -(2 + 5 \times)$

6 and 8 age the same in base 10.

Putting in 5: $b^2-23b+130=0=$) (b-13)(b-10)=0Putting in 8: $b^2-38b+325=0=$) (b-25)(b-13)=0Putting in 8: $b^2-38b+325=0=$) (b-25)(b-13)=0We see that b=13 is a common root of the quadratic equations. Hence the Markian system chould be base 13

(13 fingers)

Verification convert from base 13 to 10. $(5)x^2 - (50)x + (125)_{13} = 5x^2 - 65x + 169 + 26 + 6 = 5x^2 - 66x + 200$ $= 5(x^2 - 13x + 40)$

5 and 8 in base 10 south this equation and they do in base 13 as well.

= 5/2-61(2-8)

(6)13= (6)10 (8)13= (8)10

the manning system, have buse to (b): 3 absorbs: 5 to company of the company of t er (Werc'w) ellew) M O S + AZ P, 9 + Y 96 F + X 5 the of standard and feel materials are 8 kms & 0 = (4x9 = e x (x9 = e) 9 + e? our speed on some and some State of n source and a server are source or description of the source of the sou of the state of th بالمحاط والإلم المودارة or or or such among granters and death more Bill graph 188 farking kin e

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