Digital Electronics

Mid-semester practice

April 2025

Questions on Pages 2, 3, and 4
Answers on Pages 5, 6, and 7

Questions

Lecture 1

1. Convert the following numbers.
   (8 bits maximum for integer part and 4 bits maximum for decimal part)
   a) 51_{10} to binary
   b) -9.0625_{10} to binary
   c) 1001001_2 to denary
   d) $A40_{16}$ to denary
   e) 1011.0100_2 to hexadecimal
   f) -454_8 to hexadecimal

2. Perform the following operations for the 8-bit signed binary numbers
   a) $00010010 - 00101110$
   b) $00000101 + 00001001 + 00010001$
   c) 00101010×00000110
   d) $11111000 + 11100010$
   e) $01010110 \text{ XOR } 00001111$
   f) 00001100×10000100
   g) $01110101 \text{ AND } 11001100$

Lecture 2

1. Convert from binary to grey code
   a) 000010
   b) 001100
   c) 100101

2. Convert from grey code to binary
   a) 000100
   b) 011110
   c) 001001

3. Check whether the parity checks are valid or not
   a) 01100110 (Odd)
   b) 00000100 (Odd)
   c) 00101001 (Odd)
   d) 00010100 (Even)
   e) 00110111 (Even)
   f) 10100011 (Even)

4. Check whether the checksums are valid or not
   a) 011000 110010 000101 <u>110000</u>
   b) 101010 001100 110111 <u>010101</u>

c) 0011 1011 0100 0101 1100 1110
d) 10001110 10011001 11110101 11100001

5. Validate these bits using cyclic redundancy check
   a) 01011111100 – Generator code: 101
   b) 10011001000 – Generator code: 100
   c) 10110011100010 – Generator code: 1101

Lecture 3

1. Simplify the following expressions
   a) $(A + \bar{A}B)(B + A\bar{B})$
   b) $(X + \bar{Y} + Z)YX + \bar{X}YZ$
   c) $(A + B)(A + \bar{B})(\bar{A} + \bar{B})(\bar{A} + B)$
   d) $\overline{AC + \overline{\bar{B}\bar{C}}} + C(\overline{A + B})$
   e) $WX + XY + WY + \bar{W}Y$
   f) $(C + A + T)(C + \bar{A}) + CA\bar{T}$

Lecture 4

1. Solve the following questions using Boolean algebra.
   Give your answers in standard SOP or POS form
   a) A car has a simple alarm system which sounds if either
      - The car door is open AND the car is turned on
      - The seatbelt is not put on AND the car is turned on
      - The car door is open AND the seatbelt is put on
   b) A room ventilation system activates if either
      - The room temperature is high AND the windows are closed
      - The gas concentration is high AND the windows are closed
      - The room temperature is high AND the gas concentration is high
   c) A number filter selects certain numbers which satisfy at least one of the following.
      - The number is divisible by 6
      - The number is not a prime number AND it is not a square number
      - The number is a square number AND it is not divisible by 6

      What kind of numbers pass through the filter?

2. Obtain the simplified expressions using K-maps
   a) $\bar{A}\bar{B}\bar{C} + \bar{A}B\bar{C} + A\bar{B}\bar{C} + A\bar{B}C + ABC$
   b) $(W + \bar{X} + Y + Z)(\bar{W} + \bar{X} + Y + Z)(W + \bar{X} + Y + \bar{Z})(\bar{W} + \bar{X} + Y + \bar{Z})(W + \bar{X} + \bar{Y} + Z)$
   c) Output is HIGH if more than two out of four inputs are HIGH. If exactly two inputs are HIGH, those are don't cares.

Lecture 5

1. Select the correct answer
   a) Which has a higher fan-out?
      > CMOS
      > TTL
   b) Which has a higher power dissipation?
      > CMOS
      > TTL
   c) Which has higher switching speeds?
      > CMOS
      > TTL
   d) Which has better noise immunity?
      > CMOS
      > TTL
   e) What is speed related to?
      > Directly proportional to power dissipation
      > Inversely proportional to power dissipation
      > Directly proportional to propagation delay
      > Inversely proportional to propagation delay
   f) What is the output of a TTL gate if the input voltage is 3.0V?
      > HIGH
      > LOW
      > Invalid
   g) What is the output of a TTL gate if the input voltage is 1.33V?
      > HIGH
      > LOW
      > Invalid
   h) What is the output of a CMOS gate if the input voltage is 3.3V?
      > HIGH
      > LOW
      > Invalid
   i) What is the output of a CMOS gate if the input voltage is 0.85V?
      > HIGH
      > LOW
      > Invalid
   j) Why are NAND and NOR universal gates?
      > They can perform all the basic operations (AND, OR and NOT)
      > They help reduce the number of ICs used in a circuit
      > They are cheaper and more efficient to implement
      > All of the above

Answers

Lecture 1

1.
   a) 00110011_2
   b) 00010111.0001_2
   c) 73_{10}
   d) 2624_{10}
   e) $B.4_{16}$
   f) $-1D4_{16}$

2.
   a) 11100100
   b) 00011111
   c) 11111100
   d) 11011010
   e) 01011001
   f) Overflow (-1488_{10})
   g) 01000100

Lecture 2

1.
   a) 000011
   b) 001010
   c) 110111

2.
   a) 000111
   b) 010100
   c) 011110

3.
   a) Invalid
   b) Valid
   c) Valid
   d) Valid
   e) Invalid
   f) Valid

4.
   a) Valid
   b) Invalid
   c) Invalid

d) Valid

5.

a) Invalid
b) Valid
c) Valid

Lecture 3

1.

a) $A + B$
b) $Y(X + Z)$
c) 0
d) $\bar{A}C$
e) $WX + Y$
f) $C + \bar{A}T$

Lecture 4

1.

a) D – Car door is open; C – Car is turned on; S – Seatbelt is put on
$DCS + DC\bar{S} + \bar{D}C\bar{S} + D\bar{C}S$
b) G – Gas concentration is high; R – Room temperature is high; W – Windows are closed
$GRW + \bar{G}RW + G\bar{R}W + GR\bar{W}$
c) D – Divisible by 18; P – Prime number; S – Square number
$DSP + DS\bar{P} + D\bar{S}P + D\bar{S}\bar{P} + \bar{D}SP + \bar{D}S\bar{P} + \bar{D}\bar{S}\bar{P}$
The only term missing is $\bar{D}\bar{S}P$ which means prime numbers (obviously not a square number, nor divisible by any number except 1 and itself) pass through the filter

2.

a) $\bar{A}\bar{C} + A\bar{B} + AC$
b) $\bar{X} + Y(W + Z)$
c) If the inputs are A, B, C and D
$AB + CD$

Lecture 5

1.

a) CMOS
b) TTL
c) TTL
d) CMOS
e) Inversely proportional to propagation delay
f) HIGH
g) Invalid

h) Invalid
i) LOW
j) All of the above