MS101 – 2023-24/II Spring

Midsem Examination (Feb 28, 2024)

EE Questions and Solutions

Total marks: 38.5

Q–1 Which of the following unregulated DC power supplies has the highest peak-to-peak ripple voltage? A) An unregulated DC power supply made of a half-wave rectifier with load resistance R_L = 2 kΩ and a filter capacitance C = 100 µF. b) An unregulated DC power supply made of a half-wave rectifier with load resistance R_L = 2 kΩ and a filter capacitance C = 1000 µF. c) An unregulated DC power supply made of a bridge rectifier with load resistance R_L = 2 kΩ and a filter capacitance C = 100 µF. d) An unregulated DC power supply made of a bridge rectifier with load resistance R_L = 2 kΩ and a filter capacitance C = 1000 µF.	1 mark
Answer:	A
Q–2 A DC power supply is made using a step-down transformer (230 V rms to 15 V rms), and a half-wave rectifier circuit with a load resistance R_L = 20 kΩ and a filter capacitance C = 1000µF. You may assume the diode drop to be 0.6 V and the resistance of wires used for transformer windings to be negligible. What is the peak output voltage in volts?	1.5 marks
Answer: Peak output voltage = [15 x sqrt(2)] – 0.6 = 21.21 – 0.6 = 20.61 V (Accepted range: 20.6 to 21.22)	20.61 Range (20.6 to 21.22)
Q-3 Consider the binary number "10101011". This number is rotated right by 2 places. (For rotating right by one place, we move each bit one place to the right and bring the least significant bit of the original number to the most significant position). What is the rotated number in hexadecimal form?	2 marks
Answer: The binary number after rotating right two places: "11101010" Rotated number in hexadecimal : EA	EA
Q-4 Consider the hexadecimal number "FA". Write its value in decimal format if it is interpreted as: A) an unsigned number B) a signed number.	3 (=1.5 + 1.5) marks

Answer:

A) Unsigned number:
FA : 11111010 in decimal format is 250

~~B) Signed number:~~
~~Find the 2's complement of 1111 1010~~
~~2's complement of is : 0000 0101 + 0000 0001 = 0000 0110 which is -6~~

250

-6

Q-5 Write the hexadecimal equivalent of the decimal number 325.

1 mark

Answer:

145

Q-6 The truth table for a logical function Fn is given below. Using Karnaugh map (use the given Karnaugh map format) obtain the minimized logic expression Fn.

4 (=2 + 2) marks

No.	A	B	C	D	Fn
00	0	0	0	0	1
01	0	0	0	1	1
02	0	0	1	0	1
03	0	0	1	1	1
04	0	1	0	0	0
05	0	1	0	1	1
06	0	1	1	0	0
07	0	1	1	1	0
08	1	0	0	0	1
09	1	0	0	1	0
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	0
13	1	1	0	1	1
14	1	1	1	0	0
15	1	1	1	1	0

AB↓ CD→	00	01	11	10
00				
01				
11				
10				

Fn =

Answer:

AB↓ CD→	00	01	11	10
00	1	1	1	1
01	0	1	0	0
11	0	1	0	0
10	1	0	0	0

AB \ CD ►	00	01	11	10
00	1	1	1	1
01	0	1	0	0
11	0	1	0	0
10	1	0	0	0

Fn $= \overline{A}.\overline{B} + \overline{B}.\overline{C}.\overline{D} + B.\overline{C}.D$

Marking scheme:

- Correct K-map entries: 2 marks (0.5 marks deducted for each wrong entry)
- Correct circling of entries: 1 mark (0.5 marks deducted for each wrong or missing circling)
- Final expression: 1 mark (0.5 marks deducted for each incorrect/missing term)

Q-7 You are given a 4-bit number ABCD where A is the most significant bit. Obtain the logic expression F which will evaluate to TRUE only when the number represented by ABCD is exactly divisible either by 3 or by 7.

6 (=2 + 2 + 2) marks

A) Write the truth table for the logical expression Fn.

B) Using Karnaugh map (use the given Karnaugh map format) obtain the minimized logic expression Fn.

AB↓ CD→	00	01	11	10
00				
01				
11				
10				

Answer:

A) Truth Table

No.	A	B	C	D	Fn
00	0	0	0	0	0
01	0	0	0	1	0
02	0	0	1	0	0
03	0	0	1	1	1
04	0	1	0	0	0
05	0	1	0	1	0
06	0	1	1	0	1
07	0	1	1	1	1
08	1	0	0	0	0
09	1	0	0	1	1
10	1	0	1	0	0
11	1	0	1	1	0
12	1	1	0	0	1
13	1	1	0	1	0
14	1	1	1	0	1
15	1	1	1	1	1

B) K-map entries, K-map minimization and the minimized Fn

Karnaugh Map

AB↓ CD→	00	01	11	10
00	0	0	1	0
01	0	0	1	1
11	1	0	1	1
10	0	1	0	0

AB ↓ \ CD ►	00	01	11	10
00	0	0	1	0
01	0	0	1	1
11	1	0	1	1
10	0	1	0	0

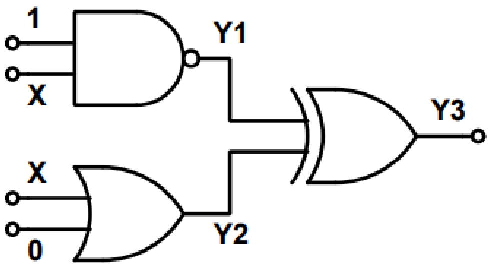
$$Fn = B\cdot C + \overline{A}\cdot C\cdot D + A\cdot B\cdot \overline{D} + A\cdot \overline{B}\cdot \overline{C}\cdot D$$

Marking scheme:

- Correct Truth table: 2 marks (0.5 marks deducted for each wrong entry)
- Correct K-map entries: 1 mark (0.5 marks deducted for each wrong or missing entries)
- Correct circling of entries: 1 mark (0.5 marks deducted for each wrong or missing circling)
- Final expression: 2 marks (0.5 marks deducted for each incorrect/missing term)

Q- 8 Evaluate the outputs Y1, Y2 and Y3 in the following digital circuit.

2 (= 0.5 + 0.5 + 1) marks



$Y1 =$

$Y2 =$

$Y3 =$

Answer:

Answer: $Y1 = \overline{X \cdot 1} = \overline{X}$

Answer: $Y2 = X + 0 = X$

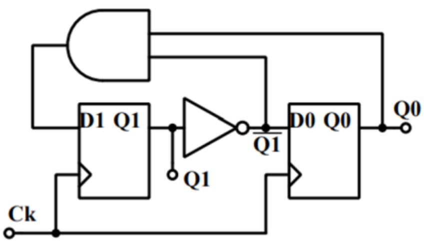
Answer: $Y3 = \overline{X} \oplus X = 1$

Marking scheme: no partial marks.
Steps need not be given.

- Y1 : 0.5 marks
- Y2 : 0.5 marks
- Y3 : 1 mark

Q - 9 Consider the digital circuit shown below. Initially, Q1 = 1 and Q0 = 0.
Write the decimal equivalent of the state Q1 Q0 after each clock (i.e. the 2-bit number Q1 Q0, where Q1 is the most significant bit) for the next 4 clocks.

4 marks (= 1x4)



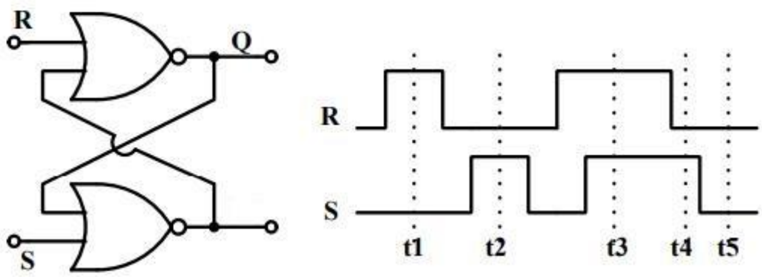
Clock	Q1	Q0	Decimal Equivalent
0	1	0	2
1			
2			
3			
4			

Answer (the sequence of states following the initial Q1 Q0 state '10')

Clock	Present Q1	Present Q0	Decimal Equivalent		D1 = Q1' Q0 (= Next Q1 after Clock edge)	D0 = Q1' (= Next Q0 after Clock edge)
0	1	0	2		0	0
1	0	0	0		0	1
2	0	1	1		1	1
3	1	1	3		0	0
4	0	0	0			

9.1 Decimal equivalent of state Q1 Q0 after the 1st clock	0
9.2 Decimal equivalent of state Q1 Q0 after the 2nd clock	1
9.3 Decimal equivalent of state Q1 Q0 after the 3rd clock	3
9.4 Decimal equivalent of state Q1 Q0 after the 4th clock	0

Q – 10 Arduino library provides the “map” function to map a value from one given range to another. It is called as: newValue = map (oldValue, fromRangelow, fromRangehigh, toRangelow, toRangehigh). What will be the returned value if the map function is called with the following arguments: 10.1 A) 512, 0, 1023, 0, 255 10.2 B) 100, 0, 1023, 255, 0	Marks 4 (= 2 + 2)
Answer 10.1 A) Straight mapping: Returned value computation = (512/1023) x 255 = 127.6 Actual value returned = 127	127 (Range 127 to 128)
10.2 B) Reversed destination range: Returned value computation = [|(100 – 1023)|/1023] x 255 = 230.07 Actual value returned = 230	230 (Range 230 to 230)
Q – 11 The “analogWrite” function in Arduino library provides a pulse width modulated output on a specified pin. It divides 2ms in 255 time slots and if *n* is the PWM value given to the function, the output is at 5 V for *n* slots and at 0 V for the remaining 255-*n* slots. What value should we choose for *n* if we want the average of the output to be close to: 11.1 A) 1.0 V 11.2 B) 2.9 V	Marks 3 (= 1.5 +1.5)
Answer A) (n/255) x 5= 1 V, n = 51	51
B) (n/255) x 5= 2.9 V, n = 147.9, rounded to 148	148
Q- 12 Assume that an Analog-to-Digital Converter (ADC) is designed to report the digital value (represented value) corresponding to the nearest level which is less than the actual analog voltage. The input voltage of the ADC varies from 0 to 5 V. The input voltage at a given instant is 3.45 V. What will be the ADC output in the binary form if the ADC is: 12.1 A) a 1-bit ADC 12.2 B) a 4-bit ADC	Marks 3 (= 1 + 2)
Answer A) 1-bit ADC 1- bit ADC has 2 levels only and by definition it would represent signals between 0 to 2.5 V as ‘0’, and 2.5 to 5 as ‘1’. In this case, the true input value of 3.45 V would be interpreted as 2.5 V. ADC output = 1	1
B) 4-bit ADC This ADC has 16 quantization levels, at intervals of 5/16 = 0.3125 V. The actual value will lie between 11 x0.3125 = 3.4375 V and 12x0.3125 = 3.75 V. Nearest level less than the actual value is 3.4375 ADC output (binary of 11) = 1011	1011
Q – 13 Simplify the following Boolean expressions: 13.1 A) X + 1 = 13.2 B) X + X = 13.3 C) X · (X + Y) = 13.4 D) $X + \overline{X} \cdot Y$ =	Marks 3 (=0.5 +0.5 +1+1)

Answer	
A) X + 1 = 1	1
B) X + X = X	X
C) X ·(X + Y) = X	X
D) $X + \overline{X} \cdot Y$ = X + Y	X + Y
Q – 14 An R-S flip flop is initially in the Set state (i.e. Q=1). For the times t1, t2, t3, t4 and t5, the R and S inputs are varied as indicated below. Find the values of the output Q :  14.1 A) Q output at time instant t1 14.2 B) Q output at time instant t2 14.3 C) Q output at time instant t3 14.4 D) Q output at time instant t4 14.5 E) Q output at time instant t5	Marks 2.5 (= 0.5 x 5)
Answer	
A) At t1, R = 1, S = 0. Hence Q = 0	0
B) At t2, R = 0, S = 1. Hence Q = 1	1
C) At t3, R = 1, S = 1. Hence Q = 0	0
D) At t4, R = 0, S = 1. Hence Q = 1	1
E) At t5, R = 0, S = 0. Hence Q = 1	1