



# VIT<sup>®</sup>

Vellore Institute of Technology  
(Deemed to be University under section 3 of UGC Act, 1956)

REG.NO.:

**NAME OF THE SCHOOL**  
**CONTINUOUS ASSESSMENT TEST - II**  
**FALL SEMESTER 2024-2025**

SLOT: E2+TE2

**Programme Name & Branch** : B.Tech/ BCI, BCB, BCE, BCT, BDS, BKT, BAI

**Course Code and Course Name** : BECE102L/ Digital Systems Design

**Faculty Name(s)** : ANITHA R, RAVI S, LAVANYA N, PALLA  
PENCHALAI AH, AVINASH CHANDRA, RAJESH N, SHWETA B THOMAS, NAVEEN MISHRA,  
SAURABH NAGAR, ANJU THOMAS, SIDHARTH GAUTAM, JAFFINO, HEMANTA KUMAR  
SAHU, NAWAZ SHAFI, VETRIVEERAN RAJAMANI, GEORGE JACOB, SWATI G, ASHUTOSH  
MAHAJAN, NISHA J S

**Date of Examination** : 17-Oct-2024

**Exam Duration** : 90 minutes

**Maximum Marks: 50**

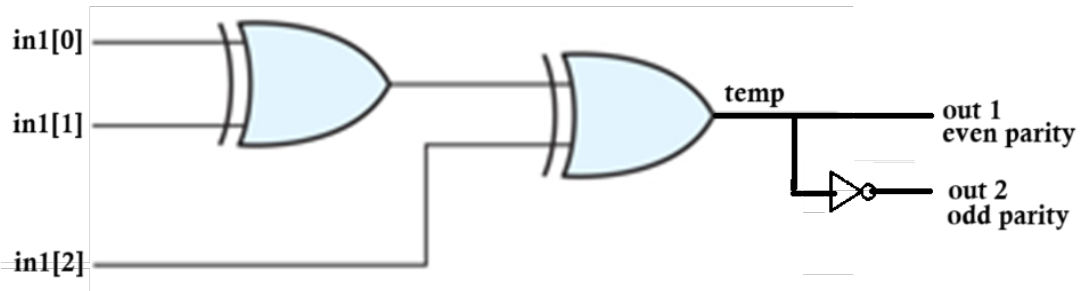
**General instruction(s):**

- Answer All Questions
- M - Max mark; CO – Course Outcome; BL – Blooms Taxonomy Level (1 – Remember, 2 – Understand, 3 – Apply, 4 – Analyse, 5 – Evaluate, 6 – Create)
- Course Outcomes (Type the CO statements covered in this question paper. Use the CO number as per the syllabus copy)

Q. No	Question	M	CO	B L
1.	<p>Identify the following code and draw the circuit with truth table and write the test bench.</p> <pre> module cat2q1 (in1, out1, out2);   input [2:0]in1;output out1, out2;   reg temp;   always@(in1)   begin     temp &lt;= in1[0]^in1[1]^in1[2];     if(temp)     begin       out1&lt;= 1'b1;       out2 &lt;= 1'b0;     end     else     begin       out1 &lt;= 1'b0;       out2 &lt;= 1'b1;     end   end end endmodule </pre> <p><b>Ans: 3-bit Even and odd parity generator / Two bit Even and odd parity checker</b></p>	1 0		



in1[0]	in1[1]	in1[2]	Temp	out 1	out 2
0	0	0	0	0	1
0	0	1	1	1	0
0	1	0	1	1	0
0	1	1	0	0	1
1	0	0	1	1	0
1	0	1	0	0	1
1	1	0	0	0	1
1	1	1	1	1	0



```

module cat2q1 (in1, out1, out2);
  input [2:0]in1;output reg out1, out2;
  reg temp;
  always@(*)
  begin
    temp <=in1[0]^in1[1]^in1[2];
    if(temp)
    begin
      out1 <= 1'b1;
      out2 <= 1'b0;
    end
    else
    begin
      out1 <= 1'b0;
      out2 <= 1'b1;
    end
  end
end
endmodule

```

```

module parityTB;
reg [2:0]in1;
wire out1, out2;
integer i;
cat2q1 parity(in1, out1, out2);
initial
begin

```



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	<pre>for(i=3'b0; i&lt;8; i=i+1) begin in1=i; #10; end \$stop; end</pre>																																																																																																																																																																																																																																											
2.	<p>Using a flowchart, demonstrate the multiplication of 5 and -13 using the booth algorithm. Assume 5 and -13 of 5 bits.</p> <p><b>Ans:</b></p> <p>Multiplication 00101 x 10011 (5x-13 = -65)  A = 00000    Q = 10011    M = 00101    Q<sub>-1</sub> = 0    Count = 5 (Number of bits)</p> <table border="1"> <thead> <tr> <th>C</th> <th colspan="5">A</th> <th colspan="5">Q</th> <th></th> <th>Action</th> </tr> <tr> <th></th> <th>A<sub>4</sub></th> <th>A<sub>3</sub></th> <th>A<sub>2</sub></th> <th>A<sub>1</sub></th> <th>A<sub>0</sub></th> <th>Q<sub>4</sub></th> <th>Q<sub>3</sub></th> <th>Q<sub>2</sub></th> <th>Q<sub>1</sub></th> <th>Q<sub>0</sub></th> <th>Q<sub>-1</sub></th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td rowspan="3">5</td> <td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> <td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td> <td></td> <td>Check the code for Q<sub>0</sub> and Q<sub>-1</sub> (10)</td> </tr> <tr> <td colspan="13"> <math>A = A - M</math>  <math>A = A + 2's \text{ Comp}(M)</math> </td> </tr> <tr> <td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td> <td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td> <td></td> <td>00000+ 11011 11011</td> </tr> <tr> <td rowspan="2">4</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>1</td> <td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td> <td></td> <td>ARS</td> </tr> <tr> <td>1</td><td>1</td><td>1</td><td>1</td><td>0</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td> <td></td> <td>Check the code for Q<sub>0</sub> and Q<sub>-1</sub> (11)</td> </tr> <tr> <td rowspan="3">3</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>0</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td> <td></td> <td>Check the code for Q<sub>0</sub> and Q<sub>-1</sub> (01)</td> </tr> <tr> <td colspan="13"> <math>A = A + M</math> </td> </tr> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td> <td></td> <td>11110 00101 100011</td> </tr> <tr> <td rowspan="2">2</td> <td>0</td><td>0</td><td>0</td><td>0</td><td>1</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td> <td></td> <td>ARS</td> </tr> <tr> <td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td> <td></td> <td>Check the code for Q<sub>0</sub> and Q<sub>-1</sub> (00)</td> </tr> <tr> <td rowspan="3">1</td> <td>0</td><td>0</td><td>0</td><td>0</td><td>0</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td> <td></td> <td>Check the code for Q<sub>0</sub> and Q<sub>-1</sub> (10)</td> </tr> <tr> <td colspan="13"> <math>A = A - M</math>  <math>A = A + 2's \text{ Comp}(M)</math> </td> </tr> <tr> <td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td> <td></td> <td>00000+ 11011 11011</td> </tr> <tr> <td>0</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>1</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td> <td></td> <td>ARS</td> </tr> <tr> <td>0</td> <td>1</td><td>1</td><td>1</td><td>0</td><td>1</td> <td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td> <td></td> <td></td> </tr> </tbody> </table> <p><b>Answer = 111011111</b></p>	C	A					Q						Action		A <sub>4</sub>	A <sub>3</sub>	A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	Q <sub>4</sub>	Q <sub>3</sub>	Q <sub>2</sub>	Q <sub>1</sub>	Q <sub>0</sub>	Q <sub>-1</sub>			5	0	0	0	0	0	1	0	0	1	1	0		Check the code for Q <sub>0</sub> and Q <sub>-1</sub> (10)	$A = A - M$ $A = A + 2's \text{ Comp}(M)$													1	1	1	0	1	1	1	0	0	1	1	0		00000+ 11011 11011	4	1	1	1	0	1	1	1	0	0	1	1		ARS	1	1	1	1	0	1	1	1	0	0	1		Check the code for Q <sub>0</sub> and Q <sub>-1</sub> (11)	3	1	1	1	1	0	1	1	1	0	0	1		Check the code for Q <sub>0</sub> and Q <sub>-1</sub> (01)	$A = A + M$													0	0	0	0	1	1	1	1	1	0	0	1		11110 00101 100011	2	0	0	0	0	1	1	1	1	1	0	0		ARS	0	0	0	0	0	1	1	1	1	1	0		Check the code for Q <sub>0</sub> and Q <sub>-1</sub> (00)	1	0	0	0	0	0	1	1	1	1	1	0		Check the code for Q <sub>0</sub> and Q <sub>-1</sub> (10)	$A = A - M$ $A = A + 2's \text{ Comp}(M)$													1	1	1	0	1	1	1	1	1	1	1	0		00000+ 11011 11011	0	1	1	1	0	1	1	1	1	1	1	1		ARS	0	1	1	1	0	1	1	1	1	1	1	1			1 0		
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3.	Design a 2 bit comparator and use it to construct a 4 bit comparator.	1 0																																																																																																																																																																																																																																										



4.	<p>Consider a certain type of flip-flop with inputs <math>X_1</math> and <math>X_2</math> and excitation table as:</p> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th>Present State</th> <th>Next State</th> <th colspan="2">Inputs</th> </tr> <tr> <th><math>Q_n</math></th> <th><math>Q_{n+1}</math></th> <th><math>X_1</math></th> <th><math>X_2</math></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>X</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>X</td> </tr> </tbody> </table> <p>Design a synchronous counter using this flip-flop for the count sequence 0, 1, 3, 5, 6, 0, by considering that if the present state is an undesired one, it should transit to 0 on application of clock pulse.</p> <p>Flip Flop <math>X_1 X_2</math> Excitation table of <math>X_1 X_2</math> FF is</p> <table border="1" style="margin: 10px auto; border-collapse: collapse;"> <thead> <tr> <th><math>Q_n</math></th> <th><math>Q_{n+1}</math></th> <th><math>X_1</math></th> <th><math>X_2</math></th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>x</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>x</td> </tr> </tbody> </table> <p>State Diagram</p>	Present State	Next State	Inputs		$Q_n$	$Q_{n+1}$	$X_1$	$X_2$	0	0	0	0	0	1	0	1	1	0	0	X	1	1	1	X	$Q_n$	$Q_{n+1}$	$X_1$	$X_2$	0	0	0	0	0	1	0	1	1	0	0	x	1	1	1	x	1 0		
Present State	Next State	Inputs																																														
$Q_n$	$Q_{n+1}$	$X_1$	$X_2$																																													
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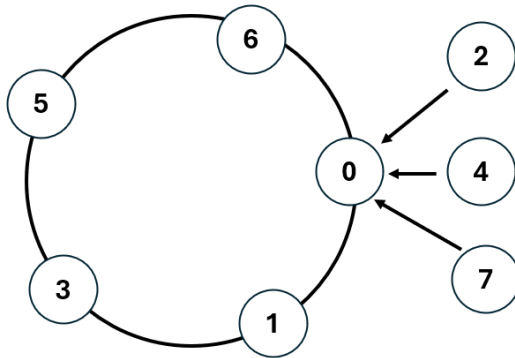
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Number of Flip flop : 3

Excitation Table of the counter

	Present State			Next State			Inputs of FFs					
	Qa	Qb	Qc	Qa+1	Qb+1	Qc+1	X1a	X2a	X1b	X2b	X1c	X2c
0	0	0	0	0	0	1	0	0	0	0	0	1
1	0	0	1	0	1	1	0	0	0	1	1	X
0	0	1	0	0	0	0	0	0	0	X	0	0
3	0	1	1	1	0	1	0	1	0	X	1	X
4	1	0	0	0	0	0	0	X	0	0	0	0
5	1	0	1	1	1	0	1	X	0	1	0	X
6	1	1	0	0	0	0	0	X	0	X	0	0
7	1	1	1	0	0	0	0	X	0	X	0	X

X1A

	QbQc			
	00	01	11	10
Qa				
0				
1		1		

X2A

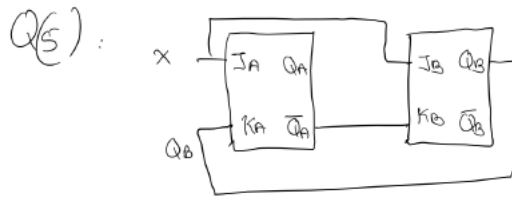
	QbQc			
	00	01	11	10
Qa				
0			1	
1	X	X	X	X



	<p style="text-align: center;"><math>X1A = Qa \cdot Qb' \cdot Qc</math>                      <math>X2A = Qb \cdot Qc</math></p> <p>X1B</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td colspan="2"></td><td colspan="4" style="text-align: center;">QbQc</td></tr> <tr><td style="text-align: center;">Qa</td><td></td><td style="text-align: center;">00</td><td style="text-align: center;">01</td><td style="text-align: center;">11</td><td style="text-align: center;">10</td></tr> <tr><td style="text-align: center;">0</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">1</td><td></td><td></td><td></td><td></td><td></td></tr> </table> <p style="text-align: center;">X1B = 0</p> <p>X2B</p> <p style="text-align: center;">QbQc</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td colspan="2"></td><td style="text-align: center;">00</td><td style="text-align: center;">01</td><td style="text-align: center;">11</td><td style="text-align: center;">10</td></tr> <tr><td style="text-align: center;">Qa</td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td style="text-align: center;">0</td><td></td><td></td><td style="border: 2px solid red; text-align: center;">1</td><td style="text-align: center;">X</td><td style="text-align: center;">X</td></tr> <tr><td style="text-align: center;">1</td><td></td><td></td><td style="border: 2px solid red; text-align: center;">1</td><td style="text-align: center;">X</td><td style="text-align: center;">X</td></tr> </table> <p style="text-align: center;">X2B = Qc</p> <p>X1C</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td colspan="2"></td><td colspan="4" style="text-align: center;">QbQc</td></tr> <tr><td style="text-align: center;">Qa</td><td></td><td style="text-align: center;">00</td><td style="text-align: center;">01</td><td style="text-align: center;">11</td><td style="text-align: center;">10</td></tr> <tr><td style="text-align: center;">0</td><td></td><td></td><td style="border: 2px solid red; text-align: center;">1</td><td style="border: 2px solid red; text-align: center;">1</td><td></td></tr> <tr><td style="text-align: center;">1</td><td></td><td></td><td></td><td></td><td></td></tr> </table> <p style="text-align: center;">X1C = Qa' . Qc</p> <p>X2C</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr><td colspan="2"></td><td colspan="4" style="text-align: center;">QbQc</td></tr> <tr><td style="text-align: center;">Qa</td><td></td><td style="text-align: center;">00</td><td style="text-align: center;">01</td><td style="text-align: center;">11</td><td style="text-align: center;">10</td></tr> <tr><td style="text-align: center;">0</td><td></td><td style="border: 2px solid red; text-align: center;">1</td><td style="border: 2px solid red; text-align: center;">X</td><td style="text-align: center;">X</td><td></td></tr> <tr><td style="text-align: center;">1</td><td></td><td></td><td style="text-align: center;">X</td><td style="text-align: center;">X</td><td></td></tr> </table> <p style="text-align: center;">X2C = Qa' . Qb'</p> <div style="text-align: center; margin-top: 20px;"> </div>			QbQc				Qa		00	01	11	10	0						1								00	01	11	10	Qa						0			1	X	X	1			1	X	X			QbQc				Qa		00	01	11	10	0			1	1		1								QbQc				Qa		00	01	11	10	0		1	X	X		1			X	X		
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1			X	X																																																																																														
<p>5.</p>	<p>A sequential circuit has two JK flip-flops with outputs <math>Q_A</math> and <math>Q_B</math> and one input <math>x</math>. The circuit is described by the following flip-flop input equations: <math>J_A = x</math>, <math>K_A = Q_B</math>, <math>J_B = x</math>, <math>K_B = \overline{Q_A}</math>.</p> <p>(a) Derive the state equations <math>Q_A(t+1)</math> and <math>Q_B(t+1)</math> by substituting the input equations for the J and K variables. (b) Draw the state diagram of the circuit.</p> <p style="background-color: yellow; display: inline-block; padding: 2px;">Ans:</p>	<p>1 0</p>																																																																																																



Sol:  $\rightarrow$  we know,  $Q(t+1) = JQ' + K'Q$   
 $A(t+1) = J_A Q'_A + K'_A Q_A = xA' + BA$   
 $B(t+1) = J_B Q'_B + K'_B Q_B = xB' + A'B$



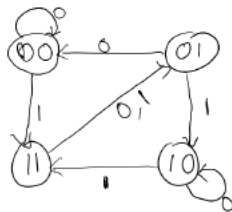
We know that  $Q(k+1) = J\bar{Q} + \bar{K}Q$

So  $Q_A(k+1) = J_A \bar{Q}_A + \bar{K}_A Q_A = x \cdot \bar{Q}_A + \bar{Q}_B \cdot Q_A$

$Q_B(k+1) = J_B \bar{Q}_B + \bar{K}_B Q_B = x \cdot \bar{Q}_B + \bar{Q}_A \cdot Q_B$   
 $= x \cdot \bar{Q}_B + Q_A \cdot Q_B$

State Table

$Q_A$	$Q_B$	$x$	$Q_A(k+1)$ $x \cdot \bar{Q}_A + \bar{Q}_B \cdot Q_A$	$Q_B(k+1)$ $x \cdot \bar{Q}_B + Q_A \cdot Q_B$
0	0	0	$0 \cdot 1 + 1 \cdot 0 = 0$	$0 \cdot 1 + 0 \cdot 0 = 0$
0	0	1	$1 \cdot 1 + 1 \cdot 0 = 1$	$1 \cdot 1 + 0 \cdot 0 = 1$
0	1	0	$0 \cdot 1 + 0 \cdot 0 = 0$	$0 \cdot 0 + 0 \cdot 1 = 0$
0	1	1	$1 \cdot 1 + 0 \cdot 0 = 1$	$1 \cdot 0 + 0 \cdot 1 = 0$
1	0	0	$0 \cdot 0 + 1 \cdot 1 = 1$	$0 \cdot 1 + 1 \cdot 0 = 0$
1	0	1	$1 \cdot 0 + 1 \cdot 1 = 1$	$1 \cdot 1 + 1 \cdot 0 = 1$
1	1	0	$0 \cdot 0 + 0 \cdot 1 = 0$	$0 \cdot 0 + 1 \cdot 1 = 1$
1	1	1	$1 \cdot 0 + 0 \cdot 1 = 0$	$1 \cdot 0 + 1 \cdot 1 = 1$



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