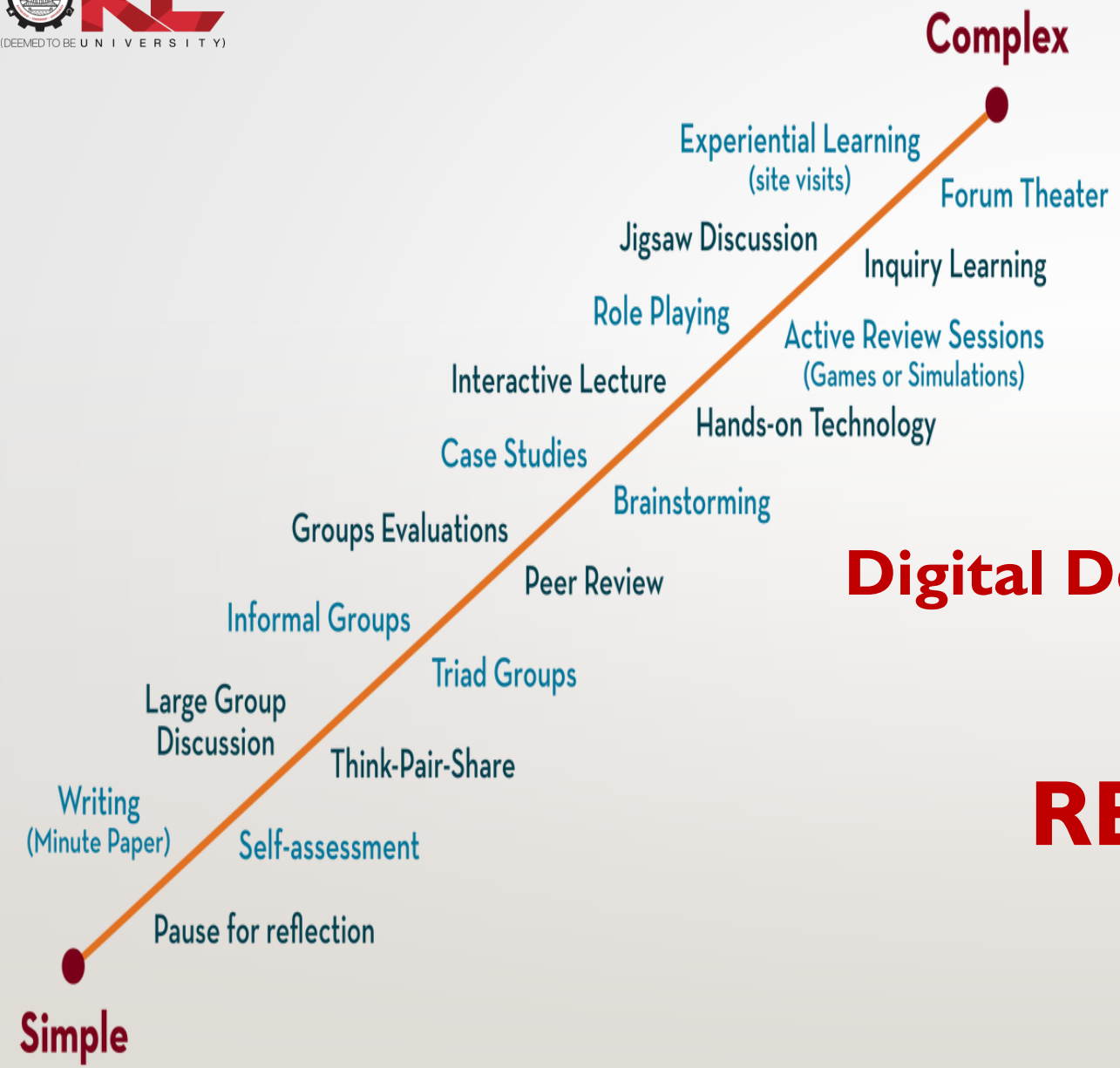


Department of BES-II

Digital Design and Computer Architecture

23EC1202

Topic:

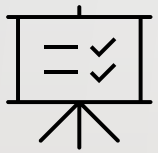
REVERSIBLE GATES

Session No: 11

AIM OF THE SESSION

To familiarize students with the basic concept of Reversible Logic Gates.

INSTRUCTIONAL OBJECTIVES



This Session is designed to:

1. Define what reversible logic gates are and describe their unique characteristics.
2. Identify common reversible logic gates, including Toffoli gate, Fredkin gate, and Peres gate.

LEARNING OUTCOMES

At the end of this session, you should be able to:

Acquire a comprehensive understanding of reversible logic gates, their principles, applications, and implications in the field of reversible computing.

INTRODUCTION

- A reversible logic gate is a type of digital logic gate that operates in such a way that its input values can be uniquely determined from its output values, and vice versa.

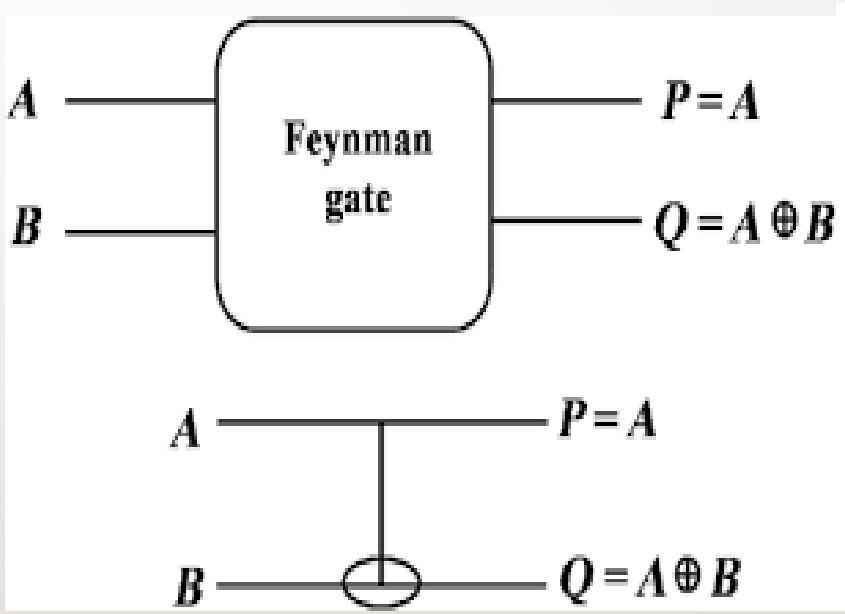
- The primary characteristic of a reversible logic gate is that it satisfies the reversibility condition, ensuring a one-to-one mapping between input and output states.

- This reversibility property is crucial for minimizing energy dissipation in computation, making reversible logic gates valuable in the development of energy-efficient computing systems.

BASIC REVERSIBLE LOGIC GATES

Feynman Gate

- Feynman gate is a 2*2 one through reversible gate as shown in figure. The input vector is I(A, B) and the output vector is O(P, Q).
- The outputs are defined by P=A, Q = A ⊕ B. Quantum cost of a Feynman gate is 1.
- Feynman Gate (FG) can be used as a copying gate. This gate is useful for duplication of the required outputs.



A	B	P	Q
0	0	0	0
0	1	0	1
1	0	1	1
1	1	1	0

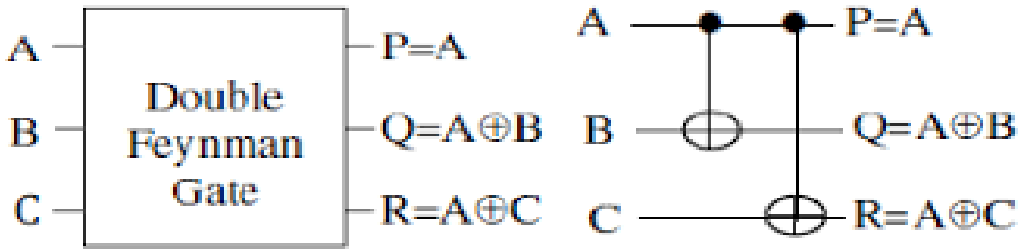
BASIC REVERSIBLE LOGIC GATES (Cont..)

Double Feynman Gate (F2G)

Figure shows a 3*3 Double Feynman gate. The input vector is I (A, B, C) and the output vector is O (P, Q, R).

The outputs are defined by
P = A, Q = A ⊕ B, R = A ⊕ C.

Quantum cost of double Feynman gate is 2.



A	B	C	P	Q	R
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	0
0	1	1	0	1	1
1	0	0	1	1	1
1	0	1	1	1	0
1	1	0	1	0	1
1	1	1	1	0	0

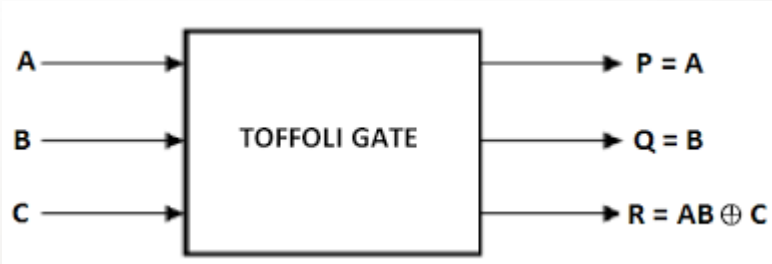
BASIC REVERSIBLE LOGIC GATES (Cont..)

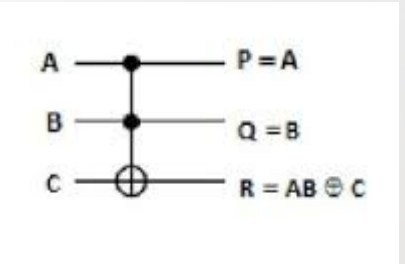
Toffoli Gate:

Fig shows a 3*3 Toffoli gate. The input vector is I (A, B, C) and the output vector is O(P,Q,R).

The outputs are defined by P=A, Q=B, R=AB⊕C.

Quantum cost of a Toffoli gate is 5





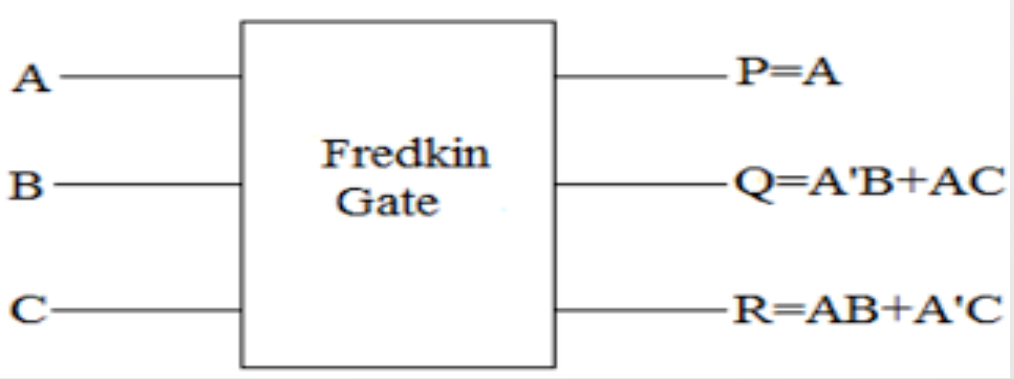
Input			Output		
A	B	C	P	Q	R
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	0
0	1	1	0	1	1
1	0	0	1	0	0
1	0	1	1	0	1
1	1	0	1	1	1
1	1	1	1	1	0

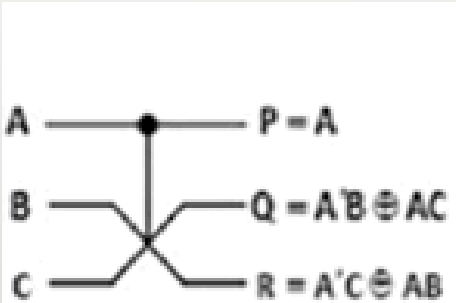
BASIC REVERSIBLE LOGIC GATES (Cont..)

Fredkin Gate:
Fig shows a 3*3 Fredkin gate.

The input vector is I (A, B, C) and the output vector is O(P, Q, R).

The output is defined by P=A, Q=A′B⊕AC and R=A′C⊕AB. Quantum cost of a Fredkin gate is 5.





A	B	C	P	Q	R
0	0	0	0	0	0
0	0	1	0	0	1
0	1	0	0	1	0
0	1	1	0	1	1
1	0	0	1	0	0
1	0	1	1	1	0
1	1	0	1	0	1
1	1	1	1	1	1

Applications of Reversible Logic Gates

Reversible computing may have applications in computer security and transaction processing

1. Low power CMOS
2. Quantum computer
3. Nanotechnology
4. Optical computing
5. Design of low power arithmetic and data path for digital signal processing (DSP)
6. Field Programmable Gate Arrays (FPGAs) in CMOS technology for extremely low power, high testability and self-repair

SELF-ASSESSMENT QUESTIONS

1. The output is high if either of the input is high. The statements represents

(a) NAND Gate

(b) OR Gate

(c) AND Gate

(d) EX-OR Gate

2. Which one of the following is the reversible process?

(a) Heat Transfer through an infinitesimal temperature difference

(b) Throttling Process

(c) Free Expansion

(d) More than one of the above

TERMINAL QUESTIONS

1. Describe the concept of reversible gates.

2. List out the advantages and applications of reversible logic gates.

REFERENCES FOR FURTHER LEARNING OF THE SESSION

Reference Books:

1. H. r. bhagyalakshmi, M. k. venkatesha," an improved design of a multiplier using reversible Logic gates" International Journal of Engineering Science and Technology Vol. 2(8), 2010, 3838-3845.

2. Thapliyal H, M. B.Ss hrinivas." A New Reversible TSG Gate and Its Application for Designing Efficient Adder Circuits". Centre for VLSI and Embedded System Technologies International Institute of Information Technology, Hyderabad, 500019, India

Sites and Web links:

1. https://www.academia.edu/34928486/Introduction_to_Reversible_Logic_Gates_and_its_Application

THANK YOU

(DEEMED TO BE UNIVERSITY)

Team – Digital Design & Computer Architecture