CSE 3162 : Network-on-Chip

Programme: B.Tech (CSE) Year: 3rd Semester: 6th

Course: Program Elective Credits: 3 Hours: 40

Course Context and Overview (100 words):

In the field of interconnection networks, there is a growing interest and amount of research in the on-chip domain. The integrated circuit technology has evolved to accommodate a multiprocessing device capable of high-performance computation. As a result of the high integration scale in the deep sub-micron domain and the increasing number of connecting elements, Network-on-Chip (NoC) has become a need and will influence the performance of the final system. Therefore, any gain in the efficiency of the on-chip interconnection layer will be highly beneficial.

In this course, we will cover the fundamentals of NoC– topology, routing, flow-control, microarchitecture, and network interfaces. The course will also focus on state-of-the-art research and case studies in the field of NoC along with hand-on experience of NoC simulator.

Prerequisites Courses:

Computer Networks

Course outcomes (COs):

On completion of this course, the students will have the ability to:
CO1: Understand the basic principles of Network-on-Chip.
CO2: Understand the various techniques of NoC topologies.
CO3: Understand the switching, flow control, routing techniques and router microarchitecture.
CO4: Carry out experiments, analyze results and to make necessary conclusions using NoC simulator.

Course Topics:

Contents	**Lecture Hours**	**Unit Hours**
UNIT – 1: Introduction to Network-on-chip (NoC)		6
1. Introduction of Network-on-Chip.	1	
2. NoC Building Blocks: Topology, Routing, Flow Control, Router Microarchitecture	2	

3. Network Design Considerations.		
4. NoC for Chip Multiprocessors (CMPs)	2	
5. Performance Parameters	1	
UNIT - 2: Topology Exploration		
1. Topology Basics: Metrics For Comparing Topologies	1	
2. Direct Topologies	2	
3. Indirect Topologies	2	7
4. Irregular Topologies	1	
5. Case Study on various topologies: Hands-on experiments in exploring various NoC topologies using NoC simulator.	1	
UNIT–3: Flow Control		
1. Messages, Packets, Flits and Phits	1	
2. Message Based Flow Control: Circuit Switching	1	
3. Packet Based Flow Control: Store and Forward, Virtual Cut Through	2	10
4. Flit Based Flow Control: Wormhole	1	
5. Virtual Channels	1	
6. Deadlock Free Flow Control: Escape VCs	1	
7. Buffer Management and Backpressure	3	
UNIT-4: Routing Algorithms and Implementation Mechanisms		
1. Routing Basics, Taxonomy of Routing Algorithms 2. Deadlock, Livelock and Starvation	2	
3. Deterministic Routing Algorithms	2	
4. Adaptive Routing Algorithms	2	12
5. Topology Agnostic Routing Algorithms	1	
6. Table-Based Routing: Source Routing, Node-Table Routing	2	
7. Algorithmic Routing	1	
8. Logic-Based Distributed Routing	2	

UNIT-5: Application Mapping and Performance Analysis		
1. Application Mapping Strategies for NoC	2	5
2. Measures of On-Chip Interconnection Network Performance	1	
3. Network workloads	1	
4. Hands on experiments on comparison of Routing Techniques/ Switching Techniques using NoC simulator.	1	

Text Books:

1. Principles and Practices of Interconnection Networks by William Dally and Brian Towles. Morgan Kaufmann, 2003.
2. Interconnection Networks: An Engineering Approach by Jose Duato, Sudhakar Yalamanchili, Lionel M. N. Morgan Kaufmann, 2002.

Reference Books:

1. On-chip Networks by Natalie Enright Jerger, Tushar Krishna, Li-Shiuan Peh, Morgan and Claypool Publishers, Second edition, 2017.
2. Networks on Chip by Axel Jantsch, and Hannu Tenhunen. Kluwer Acadmic Publishers, 2003.
3. Designing Network On-Chip Architectures in the Nanoscale Era by Jose Flich , Davide Bertozzi. Chapman and Hall/CRC, 2010.

Additional Resources (Video Lectures, Web resources etc.):

Evaluation Methods:

Component	Weightage (%)
Quiz (3)	30%
Assignment/Term paper (2)	20%
Mid-Term	20%
End Term	30%