MANIPAL UNIVERSITY JAIPUR

School of Information, Security and Data Science

B.Tech. Computer Science & Engineering (Data Science)

Course Hand-out

Computer System Architecture | DSE2102 | 4 Credits | 3 1 0 4

Session: July-Dec 2024 | Course Coordinator: Dr. Neeraj Kr Verma | Class: B.Tech 2nd Year / 3rd Semester

Faculty: 1. Dr. Neeraj Kr Verma 2.Mr. Ashish Pandey 3. Mr. Abhishek Dwivedi 4. Dr. Aprna Tripathi

A. Introduction:

Computer System Architecture is a fundamental course in the B.Tech curriculum that explores the design and functionality of modern computing systems. Students will learn about the core components such as the CPU, memory, and input/output devices, as well as Instruction Set Architecture (ISA). The course covers data representation, CPU design, memory hierarchy, and input/output systems. Through theoretical and practical approaches, students will gain the skills necessary to analyse and optimize computer architectures. This knowledge is essential for careers in hardware design, systems engineering, and computer science.

B. Course Outcomes: At the end of the course, students will be able to

CO	Statement	Cognitive Level
DSE2102.1:	Recall the number systems (binary, decimal, hexadecimal) and perform direct conversions between them.	Understand
DSE2102.2:	Understand the differences between Harvard Architecture and Von Neumann Architecture.	Understand
DSE2102.3:	Apply Boolean algebra concepts to minimize Boolean functions using Karnaugh Maps.	Apply
DSE2102.4:	Analyse the operation and performance of various peripheral devices and input-output interfaces.	Apply
DSE2102.5:	Evaluate the effectiveness of different memory management techniques, including memory hierarchy and virtual memory, in optimizing system performance.	Analyse

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

[PO.1]. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

[PO.2]. Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

[PO.3]. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations

[PO.4]. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

[PO.5]. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations

[PO.6]. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice

[PO.7]. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

[PO.8]. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practices

[PO.9]. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

[PO.10]. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

[PO.11]. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

[PO.12]. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

D. **Program Specific Outcomes (PSOs)**

[PSO.1]: Understand the role of the mathematical, statistical, and AI techniques in the field of data science.

[PSO.2]: Apply the acquired knowledge and expertise to perform multifaceted data analytics tasks while leveraging machine and deep learning algorithms to process large volumes of data sets.

[**PSO.3]:** Develop effective and scalable solutions to analyze and model Big Data Sets Using Advanced AI and Machine Learning Techniques.

E. Assessment Plan:

Criteria	Description	Maximum Marks
Internal Assessment (Summative)	Mid Term Examination (Closed Book)	30
	2 Quizzes (Both are compulsory), 2 Assignments (Both are compulsory to submit on time)	30
End Term Exam (Summative)	End Term Exam (Closed Book)	40
	Total	**100**
Attendance (Formative)	A minimum of 75% Attendance is required to be maintained by a student to be qualified for taking up the End Semester examination. The allowance of 25% includes all types of leaves including medical leaves.	
Make up Assignments (Formative)	Students who miss a class will have to report to the teacher about the absence. A makeup assignment on the topic taught on the day of absence will be given which has to be submitted within a week from the date of absence. No extensions will be given on this. The attendance for that day of absence will be marked blank, so that the student is not accounted for absence. These assignments are limited to a maximum of 5 throughout the entire semester.	

F. SYLLABUS

Introduction to Digital System: Number System, Direct conversion between bases, Negative numbers. Boolean Algebra, Minimization of Boolean Functions: K-Map (Up to 4-variable). **Combinational Logic Circuits:** Design Procedure, Adders, Subtractors, Decoder, Encoder, Multiplexers, Demultiplexers. **Basic Computer Concepts:** Organization and Architecture, Harvard Architecture vs Von Neumann Architecture, Structure of Digital Computer System Components, Computer Registers, Types of Registers and their Functions, Bus Architecture, Types of Buses. **Data Representation and Micro Operations:** Register Transfer Language, Arithmetic Micro-Operations, Logic Micro-Operations, Shift Micro-Operations, Signed Operand Multiplication, Booth Multiplication. **Fixed Point Representation:** Integer Representation, Arithmetic Addition, Arithmetic Subtraction, Floating Point Representation, IEEE754 Standard Floating-Point Representation. **Central Processing Unit:** General Register Organization, Stack Organization, Instruction Codes, **Instruction Set:** Characteristics, Cycle, Formats, Types, Addressing Modes. **Input-Output Organization:** Peripheral Devices, Input Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, Direct Memory Access. **Memory Organization:** Basic concept of memory system, Memory Hierarchy, Main Memory, Auxiliary Memory, 2D & 2.5D Memory Organization, Associative Memory, Cache Memory, Virtual Memory.

Lecture Plan: 48 Lectures

Lectures	Topics	Session Outcome	Mode of Delivery	Corres-ponding CO	Mode of Assessing CO
1.	Introduction to Digital System: Number System	Basic understanding about number system & its design	PPT, Lecture, Class Notes	2202.1	N. A.

2.	Introduction to Digital System: Direct conversion between bases.	Analyse and perform direct conversion between bases.	PPT, Lecture, Class Notes	2202.1	Mid Term, Quiz & End Term
3.	Introduction to Digital System: Negative Numbers	Describe to represent Negative numbers in number system.	PPT, Lecture, Class Notes	2202.1	Mid Term, Quiz & End Term
4.	Introduction to Digital System: Boolean Algebra	Understanding Boolean Algebra theory	PPT, Lecture, Class Notes	2202.1	Mid Term, Quiz & End Term
5.	Introduction to Digital System: K-Maps	Understanding the concept of Boolean Functions K-Map.	PPT, Lecture, Class Notes	2202.1	Mid Term, Quiz & End Term
6.	Introduction to Digital System: K-Maps	Apply Minimization of K-Map (Up to 4-variable)	PPT, Lecture, Class Notes	2202.2	Mid Term, Quiz & End Term
7.	Combinational Logic Circuits: Design Procedure	Understanding about Design Procedure of Combinational Logic Circuits	PPT, Lecture, Class Notes	2202.2	Mid Term, Quiz & End Term
8.	Combinational Logic Circuits: Adders, Subtractors	Design & Analyse of Adders, Subtractors of Combinational Logic Circuits.	PPT, Lecture, Class Notes	2202.2	Mid Term, Quiz & End Term
9.	Combinational Logic Circuits: Decoder, Encoder	Design & Analyse of Decoder, Encoder of Combinational Logic Circuits.	PPT, Lecture, Class Notes	2202.2	Mid Term, Quiz & End Term
10.	Combinational Logic Circuits: Multiplexers, Demultiplexers	Design & Analyse of Multiplexers, Demultiplexers of Combinational Logic Circuits.	PPT, Lecture, Class Notes	2202.1 & 2202.2	Mid Term, Quiz & End Term
11.	Basic Computer Concepts: Organization and Architecture	Understanding the concept of Computer Organization and Architecture,	PPT, Lecture, Class Notes	2202.1 & 2202.2	Mid Term, Quiz & End Term
12.	Basic Computer Concepts: Basic Architecture	Describe different Architecture like Harvard Architecture & Von Neumann Architecture	PPT, Lecture, Class Notes	2202.1 & 2202.2	Mid Term, Quiz & End Term
13.	Basic Computer Concepts: Computer Structure	Understanding about the Structure of Digital Computer System and its Components.	PPT, Lecture, Class Notes	2202.1 & 2202.2	Mid Term, Quiz & End Term
14.	Basic Computer Concepts: Registers	Understanding about Computer Registers its types & functions.	PPT, Lecture, Class Notes	2202.1 & 2202.2	Mid Term, Quiz & End Term

15.	Basic Computer Concepts: Bus	Design & Analyses of different Bus Architectures & its types.	PPT, Lecture, Class Notes	2202.2 & 2202.3	Mid Term, Quiz & End Term
16.	Data Representation and Micro Operations: RTL	Understand & Apply Register Transfer Language for performing Micro Operations,	PPT, Lecture, Class Notes	2202.3	Mid Term, Quiz & End Term
17.	Data Representation and Micro Operations: Arithmetic Operations	Apply & Evaluate Arithmetic Micro-Operations.	PPT, Lecture, Class Notes	2202.3	Mid Term, Quiz & End Term
18.	Data Representation and Micro Operations: Logic Operations	Apply & Evaluate Logic Micro-Operations	PPT, Lecture, Class Notes	2202.3	Mid Term, Quiz & End Term
19.	Data Representation and Micro Operations: Shift Operations	Apply & Evaluate Shift Micro-Operations	PPT, Lecture, Class Notes	2202.3	Mid Term, Quiz & End Term
20.	Data Representation and Micro Operations: Signed Operand Multiplication	Apply & Evaluate Signed Operand Multiplication	PPT, Lecture, Class Notes	2202.3	Mid Term, Quiz & End Term
21.	Data Representation and Micro Operations: Booth Algorithm	Implementation of Booth Multiplication	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
22.	Fixed Point Representation: Integer	Understanding about the Integer Representation,	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
23.	Fixed Point Representation: Addition & Subtraction	Apply & Evaluate Arithmetic Addition, Arithmetic Subtraction	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
24.	Fixed Point Representation: Floating Point	Apply Floating Point Representation	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
25.	Fixed Point Representation: IEEE754 Standard Floating-Point	Understanding about IEEE754 Standard Floating-Point Representation	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
Mid-Term Examination-1					
26.	Central Processing Unit: General Register	Understanding about General Register Organization	PPT, Lecture, Class Notes	2202.3	Quiz & End Term

27.	Central Processing Unit: General Register	Understanding about General Register Organization	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
28.	Central Processing Unit: Stack Organization	Understand to Stack Organization	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
29.	Central Processing Unit: Stack Organization	Understand to Stack Organization	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
30.	Central Processing Unit: Instruction Codes	Understand to Instruction Codes & its requirement in CPU.	PPT, Lecture, Class Notes	2202.3	Quiz & End Term
31.	Instruction Set: Characteristics	Understanding about Instruction Set & its Characteristics.	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
32.	Instruction Set: Instruction Set Cycle	Understand the Instruction Set Cycle	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
33.	Instruction Set: Formats & Types	Understand the Instruction Set Formats and its types	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
34.	Instruction Set: Addressing Modes	Design & Analyse about various Addressing Modes of Instruction Set.	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
35.	Instruction Set: Addressing Modes	Design & Analyse about various Addressing Modes of Instruction Set.	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
36.	Input-Output Organization: Peripheral Devices	Basic Understanding to Peripheral Devices	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
37.	Input-Output Organization: I/O Interface	Understand & Apply Input Output Interface	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
38.	Input-Output Organization: Data Transfer	Apply & Asynchronous Data Transfer	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
39.	Input-Output Organization: Modes of Transfer	Design & Analyses of Modes of Transfer	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
40.	Input-Output Organization: Modes of Transfer	Design & Analyses of Modes of Transfer	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
41.	Input-Output Organization: Interrupt	Apply & Evaluate Priority Interrupt	PPT, Lecture, Class Notes	2202.4	Quiz & End Term
42.	Input-Output Organization: DMA	Basic Understanding about Direct Memory Access	PPT, Lecture, Class Notes	2202.4	Quiz & End Term

43.	Memory Organization: Memory System	Basic Understanding about the concept of memory system in Computer	PPT, Lecture, Class Notes	2202.5	Quiz & End Term
44.	Memory Organization: Memory Hierarchy	Understand & Evaluate various types of Memories Hierarchy	PPT, Lecture, Class Notes	2202.5	Quiz & End Term
45.	Memory Organization: Main Memory, Auxiliary Memory	Understand & Evaluate Main Memory and Auxiliary Memory	PPT, Lecture, Class Notes	2202.5	Quiz & End Term
46.	Memory Organization: 2D & 2.5D Memory	Understand & Evaluate 2D & 2.5D Memory Organization	PPT, Lecture, Class Notes	2202.5	Quiz & End Term
47.	Memory Organization: Associative Memory	Understand & Evaluate Associative Memory.	Lectures, Flipped Classroom	2202.5	Quiz & End Term
48.	Memory Organization: Cache Memory & Virtual Memory	Understand & Evaluate Cache Memory & Virtual Memory	Lectures, Flipped Classroom	2202.5	Quiz & End Term

G. Target attainment (%) for course outcomes:

CO	Target Attainment (%)
DSE2102.1	**80**
DSE2102.2	**80**
DSE2102.3	**80**
DSE2102.4	**80**
DSE2102.5	**75**

A. Course Articulation Matrix: (Mapping of COs with POs)

CO	STATEMENT	CORRELATION WITH PROGRAM OUTCOMES												CORRELATION WITH PROGRAM SPECIFIC OUTCOMES		
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
2202.1	Recall the number systems (binary, decimal, hexadecimal) and perform direct conversions between them.	2	2	1	1	2	1	1	1	1	1	1	2	3	2	1
2202.2	Understand the differences between Harvard Architecture and Von Neumann Architecture.	2	1	2	1	2	2	1	1	2	1	1	2	1	2	1
2202.3	Apply Boolean algebra concepts to minimize Boolean functions using Karnaugh Maps.	3	2	2	2	3	1	1	1	1	1	1	2	3	3	2
2202.4	Analyse the operation and performance of various peripheral devices and input-output interfaces.	1	3	3	2	2	3	2	2	2	2	2	3	2	2	2
2202.5	Evaluate the effectiveness of different memory management techniques, including memory hierarchy and virtual memory, in optimizing system performance.	3	1	2	3	1	3	2	2	1	2	2	3	2	3	3

1- Low Correlation; 2- Moderate Correlation; 3- Substantial Correlation

Course Coordinator	**Head of the Department**	**Student Representative**
Name: Dr. Neeraj Kr Verma	**Prof. Akhilesh Kumar Sharma**	**Name:**
MUJ ID: MUJ1827		**Registration No.**