MANIPAL UNIVERSITY JAIPUR

School of Computers and Communication Engineering

Computer Science and Engineering with specialization in IoT and Intelligent Systems
Course Hand-out

Digital Design and Computer architecture | IS2101| 4 Credits | 3 1 0 4

Session: July 22 – Nov. 22 | Faculty: Dr. Vijay Kumar Sharma, Dr. Kusum Lata Jain, Dr. Renu Kumawat | Class: III Semester

A. **Introduction:** This course is offered by Dept. of Computer and Communication Engineering for third semester students. The core objective of this course is to describe the general organization and architecture of a computer system. It covers in detail various functional units of a computer system, machine instructions, addressing techniques and instruction sequencing. It provides a detailed coverage of logic circuits to perform various arithmetic operations and use of pipelining in the design of high-performance processors.

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

- **[2101.1].** Digital Logic Circuits and digital components for computer system
- **[2101.2].** Describe various data representation and formulate assembly language programs for a given high level language construct.
- **[2101.3].** Analyse the design of fast arithmetic circuits.
- **[2101.4].** Describe various parts of a system memory hierarchy
- **[2101.5].** Evaluate the performance of CPU, memory, and I/O operations.
- **[2101.6].** Build the required skills to read and research the current literature in computer architecture.

C. PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES

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

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

[PO.3] Design/development of solutions: 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] Conduct investigations of complex problems: 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] Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools_including prediction and modeling to complex engineering activities with an understanding of the limitations

[PO.6] The engineer and society: 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] Environment and sustainability: 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] Ethics: Apply ethical principles and commit to professional ethics_and responsibilities and norms of the engineering practices

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

[PO.10] Communication: 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] Project management and finance: 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] Life-long learning: 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

Program Specific Outcomes (PSOs)

At the end of the B Tech CCE program, the student:

PSO1: Imbibe the basic concepts and applications of computer-based Communication or networking, information sharing, signal processing, web-based systems, smart devices, and communication technology.

PSO2: Investigate prominent areas in the field of Computer and Communication Engineering to provide feasible solutions.

PSO3: Apply the contextual knowledge in the field of Computing and Communication to assess social, health, safety, and security issues relevant to the professional engineering practice.

D. Assessment Plan:

Criteria	Description	Date	Maximum Marks
Internal Assessment (Summative)	Sessional Exam I (Closed Book)	22 Sep-26 Sep	20
	Sessional Exam II (Closed Book)	10-14 Nov	20
	Quizzes and Assignments (Accumulated and Averaged)	Regularly	20
End Term Exam (Summative)	End Term Exam (Closed Book)	28 Nov- 9 Dec	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.		

E. SYLLABUS

Digital logic circuits: logic gates, Boolean algebra, map simplification, combinational circuits, flip-flops, sequential circuits; Digital components: Integrated circuits, decoders, multiplexers, registers, shift registers, binary counters; **Memory unit: Von-Neumann model for computer/ Von- Neumann architecture, performance**; Machine instructions and programs: numbers, arithmetic operations and characters, memory locations and addresses, instructions and instruction sequencing, addressing modes, assembly language, additional instructions, encoding of machine instructions; Arithmetic: addition and subtraction of signed numbers, design of fast adders, multiplication of positive numbers, signed operand multiplication, fast multiplication, integer division, floating point numbers and operations; Introduction to CPU design: instruction interpretation and execution, micro-operation and their RTL specification, memory hierarchy, main memory, types and interfacing; Cache Memory: organization and operations, levels of caches; memory management module: paging and segmentation, virtual memory, disk memory, raids, back-up memory; RISC and CISC processors; Introduction to input/output processing: programmed controlled i/o transfer, interrupt controlled I/O transfer, DMA controller; Pipelining and pipeline hazards: design issues of pipeline architecture; Instruction level parallelism and advanced issues: introduction to interconnection network and practical issues.

References:

1. M. M. Mano, Computer System Architecture, (3e), Pearson Education, 2017.

2. C. Hamacher, Z. Vranesic, S. Zaky, Computer Organization, (5e), McGraw Hill, 2011.

3. J. P. Hayes, Computer Architecture and Organization, (3e), McGraw Hill, 2017.

4. T. L. Floyd, Digital Fundamentals, (11e), Pearson Education, 2015. 5. W. Stallings, Computer Organization and Architecture–Designing for Performance, (10e), Pearson Education, 2016.

F. Lecture Plan:

Lectures	Major Topics	Topics	Mode of Delivery	Corresponding CO	Mode Of Assessing CO
1	**Introduction**	Discussion of Course handout, course Outcome	**Lecture**	**NA**	NA
2	Basic Structure of Computers	Computer Types, Functional Units, Basic Operational Concepts	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
3		Software, Performance	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
4	**Digital logic circuits**	Boolean algebra, logic gates	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
5		map simplification,	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
6		combinational circuits	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
7		flip-flops	**Lecture**	**2101.1 & 2101.6**	Mid Term I, Quiz & End Term
8		sequential circuits	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
9	**Digital components:**	Integrated circuits, decoders,	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
10		Multiplexers	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
11		Registers, shift registers, binary counters	**Lecture**	**2101.1**	Mid Term I, Quiz & End Term
12	Machine Instructions and Programs	Numbers, Arithmetic Operations and Characters	Flipped Class	**2101.2**	Mid Term I, Quiz & End Term
13		Memory Locations and Addresses, Memory Operations	Lecture	**2101.2**	Mid Term I, Quiz & End Term
14		Instructions and Instruction Sequencing	Lecture	**2101.2**& **2101.3**	Mid Term I, Quiz & End Term
15		addressing modes	Lecture	**2101.2**	Mid Term I, Quiz & End Term
16		assembly language, additional instructions, encoding of	Lecture	**2101.2 & 2101.6**	Mid Term II, Quiz & End Term
		MID TERM I			
17		Remedial Classes			
18		Remedial Classes			
19	Arithmetic	Addition and Subtraction of Signed Numbers	Lecture	**2101.3**	Mid Term II, Quiz & End Term
20		Design of Fast Adders	Lecture	**2101.3**& 1301.6	Mid Term II, Quiz & End Term
21		Carry Look Ahead Adders	Lecture	**2101.3**& 1301.5	Mid Term II, Quiz & End Term
22		Multiplication of Positive Numbers-Array Sequential Circuit	Lecture	**2101.3**& 1301.5	Mid Term II, Quiz & End Term
23		Signed Operand Multiplication-Booth Algorithm	Lecture	**2101.3**	Mid Term II, Quiz & End Term

24		Fast Multiplication-Bit Pair Recoding Of Multipliers	Lecture	**2101.3**& 1301.5	Mid Term II, Quiz & End Term
25		Carry-save addition of summands	Lecture	**2101.3**	Mid Term II, Quiz & End Term
26		Integer Division-Restoring	Lecture	**2101.3**	Mid Term II, Quiz & End Term
27		Integer Division- Nonrestoring	Lecture	**2101.3**	Mid Term II, Quiz & End Term
28		Floating Point Numbers & Operation-Standards	Lecture	**2101.3**	Mid Term II, Quiz & End Term
29		Arithmetic Operations on Floating Point Numbers	Lecture	**2101.3**	Mid Term II, Quiz & End Term
30		Tutorial	Activity		
		MIDTERM II			
33	Memory Systems	Memory Systems: Basic Concepts and different memory Hierarchy	Flipped Class	**2101.4**	Mid Term II ,Quiz & End Term
34		Speed, Size & Cost	Lecture	**2101.4**& **2101.5**	Mid Term II ,Quiz & End Term
35		types and interfacing;	Lecture	**2101.4**& **2101.5**	Mid Term II ,Quiz & End Term
36		Cache Memory: organization and operations	Lecture	**2101.4**& **2101.5**	Mid Term II ,Quiz & End Term
37		Cache Memories: Levels of Cache	Lecture	**2101.4**	Mid Term II , Quiz & End Term
38	Input / Output Processing	Memory management module: paging and segmentation, virtual memory	Lecture	**2101.4**& **2101.5**	Mid Term II , Quiz & End Term
39		RISC and CISC processors	Lecture	**2101.4**& **2101.6**	Mid Term II , Quiz & End Term
		instruction interpretation and execution	Lecture	**2101.5**	Mid Term II, Quiz & End Term
		micro-operation and their RTL specification	Lecture	**2101.5**	Mid Term II, Quiz & End Term
40		programmed controlled i/o transfer,	Lecture	**2101.5**	Mid Term II , Quiz & End Term
41		interrupt controlled I/O transfer,	Lecture	**2101.5**	Mid Term II , Quiz & End Term

42		Accessing I/O Devices,	Lecture	**2101.5**	Quiz & End Term
43		Handling Multiple Devices, Controlling Device Requests, Exceptions	Lecture	**2101.5**	Quiz & End Term
44		Direct Memory Access,	Lecture	**2101.5**	Quiz & End Term
45		DMA controller;	Lecture	**2101.5**	Quiz & End Term
46	Instructional Level Parallelism	Design issues of pipeline architecture.	Lecture	**2101.5** & **2101.6**	Quiz & End Term
47		Pipelining	Lecture	**2101.5**	Quiz & End Term
48		Data Hazards	Lecture	**2101.5**	Quiz & End Term
49		Instruction Scheduling: Static and Dynamic	Lecture	**2101.5**	Quiz & End Term
50		Instruction level parallelism	Lecture	**2101.5**	Quiz & End Term
51		Tutorial	Activity	**2101.6**	Quiz & End Term
52		Revision			
		ENDTERM			

G. 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
2101.1	Digital Logic Circuits and digital components for computer system	2	1										1	2	1	
2101.2	Describe various data representation and formulate assembly language programs for a given high level language construct	3	2										1	1	1	
2101.3	Analyse the design of fast arithmetic circuits.	2	2	1									1	1		
2101.4	Describe various parts of a system memory hierarchy	3	2										1		1	1
2101.5	Evaluate the performance of CPU, memory, and I/O operations.	3	2	1									2	1	1	2
2101.6	Build the required skills to read and research the current literature in computer architecture.												2	1		

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