ITM(SLS) Baroda University
School of Computer Science Engineering& Technology
Department of Computer Science and Engineering
B.Tech Semester III

Course Name: -Computer Architecture
Course Code: C2310C2
Course Type: Core Course
Prerequisite: -None

Teaching Schema			Credits	Examination Marks				Total Marks
L	T	P		Theory		Practical		
				External	Internal	External	Internal	
3	0	2	4	40	60	0	50	150

Course Introduction

This course provides detail of computer system's functional components, their characteristics, performance and interactions including system bus, different types of memory and CPU. This course also covers the architectural issues such as instruction set program and data types. The course emphasizes performance and cost analysis, instruction set design, pipelining, memory technology, memory hierarchy, virtual memory management, and I/O systems

Course Objective:

1. To understand the structure, function and characteristics of computer systems.
2. To understand the design of the various functional units and components of digital computers. To identify the elements of modern instructions sets and explain their impact on processor design.
3. To explain the function of each element of a memory hierarchy, identify and compare different methods for computer I/O.
4. To compare simple computer architectures and organizations based on established performance metrics.

Competencies

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

1. Apply computer architecture theory to solve the basic functional computer problem.
2. Show and assemble basic computer components.
3. Ability to integrate into working groups involved in analysis and design tasks

Course Learning Outcome:

After completing the course, the student shall be able to :

	Course Outcome	**Bloom's Level**
CO1	Identify and explain the basic structure and functional units of a digital computer	Understanding
CO2	Identify the role and working of various functional units of a computer for execution of instruction	Understanding
CO3	Design processing unit using the concepts of ALU and control logic design.	Design
CO4	Design interfacing of memory and I/O modules with CPU	Design
CO5	Implement assembly language programs and execute them	Implement
CO6	Compare performance of different types of computer architectures	Analyze

Course Syllabus:

Unit #	**Topic Name**	**No of Hours**
1	**Data storage and register transfer operations** Register Transfer and Micro-operations: Register Transfer language, Register Transfer, Bus and Memory Transfers, Arithmetic Microoperations, Logic Micro-Operations, Shift Micro-Operations, Arithmetic logical shift unit	**5**
2	**Basic Computer Organization and Design** Instruction codes, Computer registers, computer instructions, Timing and Control, Instruction cycle, Memory-Reference Instructions, Input-output	**6**

	and interrupt, Design of Basic computer, Design of Accumulator Unit.	
3	**Assembly Language Programming** Introduction, Machine Language, Assembly Language Programming: Arithmetic and logic operations, looping constructs, Subroutines, I-O Programming.	**7**
4	**Microprogrammed Control Organization:** Control Memory, Address sequencing, Micro program example, Design of Control Unit	**3**
5	**Central Processing Unit** Introduction, General Register Organization, Stack Organization, Instruction format, Addressing Modes, Data transfer and manipulation, Program control, Reduced Instruction Set Computer (RISC) & Complex Instruction Set Computer (CISC)	**5**
6	**Pipeline And Vector Processing** Flynn's taxonomy, Parallel Processing, Pipelining, Arithmetic Pipeline, Instruction Pipeline, RISC Pipeline, Vector Processing, Array Processors,	**5**
7	**Computer Arithmetic** Introduction, Addition and subtraction, Multiplication Algorithms (Booth Multiplication Algorithm), Division Algorithms, Floating Point Arithmetic operations,	**4**
8	**Input-Output Organization** Input-Output Interface, Asynchronous Data Transfer, Modes of Transfer, Priority Interrupt, DMA, Input-Output Processor (IOP), CPU IOP Communication, Serial communication.	**5**
9	**Memory Organization** Memory Hierarchy, Main Memory, Auxiliary Memory, Associative Memory, Cache Memory, Virtual Memory, Introduction to GPU.	**5**
	Total Hours	**45**

Textbook: -

1. M. Morris Mano, "Computer System Architecture", Pearson Education

References:

1. Yale N. Patt, Sanjay J. Patel, "Introduction to Computing Systems" McGraw Hill
2. Hamacher, Vranesic, Zaky, "Computer Organization", McGraw Hill.
3. Andrew S. Tanenbaum and Todd Austin, "Structured Computer Organization", Pearson Education

4. N. D. Jotwani, "Computer system organization", McGraw Hill
5. R.S.Gaonkar, "Microprocessor Architecture, Programming and Applications with 8085A", Penram International
6. Douglas Hall, Microprocessors and Interfacing, TMH

TEDx Videos:

Sr No	Link details	Description
TD1	https://www.ted.com/talks/kanawat_senanan_how_computer_memory_works?language=en	How computer memory works. Kanawat Senanan In many ways, our memories make us who we are, helping us remember our past, learn and retain skills, and plan for the future. And for the computers that often act as extensions of ourselves, memory plays much the same role.
TD2	https://www.ted.com/talks/bettina_bair_inside_your_computer Bettina Bair	How does a computer work? The critical components of a computer are the peripherals (including the mouse), the input/output subsystem (which controls what and how much information comes in and out), and the central processing unit (the brains), as well **as human-**written programs and memory

Other Videos:

Sr. No	About Video	Link	Topic
O1.	New Golden Age for Computer Architecture: Domain-Specific Hardware/Software Co-Design, Enhanced Security, Open Instruction Sets, and Agile Chip Development Speaker: John Hennessy, 2017 Turing Award Recipient / Chairman, Alphabet	https://www.youtube.com/watch?v=bfPV4x-HrUI	New Golden Age for Computer Architecture

O2.	This video explains how the pipelining concept is used to implement various tasks.	https://www.youtube.com/watch?v=3p8kZpT56lQ	Pipelining introduction
O3	Digital Circuits & Systems by Prof. S. Srinivasan, Department of Electrical Engineering, IIT Madras This video explains how the arithmetic circuit will perform various operations.	https://www.youtube.com/watch?v=NAqR-OGjgoQ	Arithmetic circuit
O4	Assembly Language & Computer Architecture Prof. Leiserson Stages of code from source code to compilation to machine code to hardware interpretation and, finally, to execution.	https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-172-performance-engineering-of-software-systems-fall-2018/lecture-videos/lecture-4-assembly-language-computer-architecture/	Assembly Language & Computer Architecture
O5	Storage and I/O Interface Prof. Jatindra Kumar Deka Department of Computer Science and Engineering, IIT Guwahati. This video describes the communication between input and output devices and storage devices	https://www.youtube.com/watch?v=cipkWLPAsKE	Storage and I/O Interface
O6	Cache memory, also called CPU memory, is random access memory (RAM) that a computer microprocessor can access more quickly than it can access regular RAM. This memory is typically integrated directly with the CPU chip or placed on a separate chip that has a separate bus interconnect with the CPU	https://www.youtube.com/watch?v=46dfG0nW3v4	CACHE MEMORY ANIMATION : Computer Architecture Concepts

Related MOOCs courses

M1	Computer Organization and Architecture: A Pedagogical Aspect Dr. Arnab Sarkar IIT Gowahati by NPTEL https://onlinecourses.nptel.ac.in/noc21_cs37/preview
M2	Computer Organization and Architecture by Vm Kamkoti by IIT Madras by NPTEL. https://nptel.ac.in/courses/106/106/106106166/
M3	Computer Architecture by David Wentzlaff. By Coursera https://www.coursera.org/learn/comparch?action=enroll

Additional Resources: - (Case Studies)

Sr No	Case Studies	Evaluation
C1 C2 C3	Recent Intel processor Pipelining in Pentium RISC-V	1 Report preparation. 2. Presentation with VIVA

Lab Experiments:

Sr No	Title of Experiments
P1	Construct the logical Half and full adder
P2	Construct the Logical Diagram for tri state bus buffers circuit using Logisim
P3	Design the computational circuit for status register
P4	Design computational circuit for Basic traffic Signal
P5	Design a 16 to 1 line multiplexer with 8-to-1-line multiplexers and one 2 to 1 line multiplexers.
P6	Design the computational circuit for 4bit arithmetic circuit
P7	Design the computational circuit for binary to Hexadecimal Conversion using 7 Segment Display
P8	Construct the Logical Diagram to perform shift operations using Logisim
P9	Write an assembly language program for performing arithmetic operations
P10	Write an assembly language program to perform subroutine
P11	Write an assembly language and factorial of number
P12	Write an assembly language to sum of even numbers
P13	Write a program to calculate the sum of series of number