Course Number : CO224
Course Title : Computer Architecture
Credits : 3
Core/Elective : Core
Prerequisites : CO221: Digital Design; CO222: Programming Methodology

Aims/Objectives:

To teach the elements of a computer and how they are organized and explain how instructions of a program will be executed by the microprocessor and how performance can be evaluated and enhanced so as to widen the vision of students in understanding programs behaviour on a computer system.

Intended Learning Outcomes (ILOs)

Knowledge: At the end of this course, a student will be able to;

- Represent and manipulate numbers in different formats.
- Describe the elements of a computer such as microprocessor, cache, memory and system buses.
- Explain the memory hierarchy and how it operates.
- Describe multiprocessor systems, SIMD, GPU and Vector and elaborate their importance.
- Design and analyse single-, multi-cycle and pipelined processors.
- Analyse issues related to system performance.

Skill: At the end of this course, a student will be able to;

- Design architectural solutions and describe designs using an HDL.
- Use simulator to test a designed processor.

Attitude:

- Gain appreciation of computer systems and how they are built and tested using tools.

Textbooks and References:

- David Patterson, John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface, 4th Edition

Topic	Time Allocated / hours			
	L	T	P	A
Overview: Difference between Computer Architecture and Computer Organization; Role of computer architecture in Computer Engineering	1			
Fundamentals of computer architecture: Von Neumann machine organization, Instruction types and addressing modes, Subroutine call and return mechanisms, Instruction decoding and execution; Registers and register files; I/O techniques and interrupts	2			

Computer arithmetic: Integer arithmetic: Multiplication, Division, Significance of range, precision and accuracy; Floating-point arithmetic: Standard methods of representation, Addition, Subtraction, Multiplication, Division; Conversion between integer and floating-point numbers	3	1		
CPU organization: Implementation of the von Neumann machine; Control and data paths, single vs. Multiple bus datapaths; Instruction set architecture, Implementing instructions; Register transfer notation, Conditional and unconditional transfers, ALU control; Control unit: hardwired vs. Micro-programmed realizations; Arithmetic units for multiplication and division.	5	1	4	4
Pipelining: Introduction to instruction level parallelism, Overview of pipelining, Pipelined data paths and control, Pipeline hazards: structural, data and control hazards, forwarding, stalls; Reducing the effect of hazards	4		2	
Memory hierarchies: Memory systems hierarchy, Electronic, magnetic and optical technologies; Main memory organization, latency, cycle-time, bandwidth and interleaving; Cache memories: Address mapping, line size, replacement and write-back policies; Virtual memory, page faults, TLBs, protection	5	1	4	3
Interfacing and communication: I/O fundamentals: Types and characteristics of I/O devices, handshaking, buffering; Buses: types of buses, synchronous and asynchronous buses, bus masters and slaves, bus arbitration, bus standards; programmed I/O, interrupt driven I/O, Interrupt structures: vectored and prioritized, interrupt overhead; Direct memory access	4		4	3
Performance issues: Metrics for computer performance, clock rate, MIPS, Cycles per instruction, benchmarks, limitations of performance metrics	2	1		
Multiprocessors : Introduction to shared memory multiprocessors, clusters, message passing systems, Flynns classification	3			
Total	29	4	14	10

L = Lectures, T = Tutorial classes, P = Practical classes, A – Assignments

Assessment	Percentage Marks	
Continuous Assessments	60	
Practical		20
Assignments		20
Mid-semester Examination		20
End of Semester Evaluation	40	
End-semester Examination		40