


CENG 309 - Introduction to Computer Architecture

Ders Kodu	Ders Adı			Dönem	
CENG 309	Introduction to Computer Architecture			Güz <input checked="" type="checkbox"/> Bahar <input type="checkbox"/> Yaz <input type="checkbox"/>	
Ders Saatleri				Kredi	AKTS
Teori	Uygulama	Laboratuvar		3	7
3	0	0			

Ders Detayları	
Bölüm	
Ders Dili	English
Ders Düzeyi	Lisans <input checked="" type="checkbox"/> Yüksek Lisans <input type="checkbox"/>
Öğrenim Türü	Örgün Öğretim <input checked="" type="checkbox"/> Uzaktan <input type="checkbox"/> Hibrit <input type="checkbox"/>
Ders Türü	Zorunlu <input checked="" type="checkbox"/> Seçmeli <input type="checkbox"/>
Ders Amacı	This course introduces the fundamental concepts of computer architecture. It covers the structure, functionality, and design of modern computer systems, focusing on the hardware-software interface, performance optimization, and system organization. Key topics include instruction set architecture (ISA), pipelining, memory hierarchies, input/output systems, and parallelism.
Ders İçeriği	The course covers an in-depth exploration of computer architecture, beginning with an overview of computer systems and their evolution, including the fundamental structures of Von Neumann and Harvard architectures. It discusses measuring computer performance through various metrics such as execution time, throughput, and latency, and explores benchmarking using SPEC, MIPS, and FLOPS, along with Amdahl's Law. The course examines Instruction Set Architecture (ISA) and machine language, comparing CISC and RISC architectures, addressing instruction formats, and exploring addressing modes. It dives into the design and operation of the Arithmetic Logic Unit (ALU), covering binary arithmetic and logical operations, and details hardware implementation. Pipelining, including stages, benefits, and performance optimization, is explained with real-world examples. The course also addresses pipeline hazards and methods for hazard resolution, including data forwarding and branch prediction. Memory hierarchy, cache design, and virtual memory are studied for their impact on performance. The curriculum includes input/output systems, buses, and Direct Memory Access (DMA). Parallel computing concepts like shared and distributed

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	memory systems, multithreading, and synchronization issues are introduced, along with the architecture of GPUs and their applications. Power efficiency, energy-efficient design techniques, and advancements in computing such as quantum and neuromorphic computing are covered, with discussions on current trends in CPU and GPU development, cloud computing, and future challenges in computer architecture.
Ders Yöntem ve Teknikleri	Anlatım <input checked="" type="checkbox"/> Soru-Cevap <input checked="" type="checkbox"/> Sunum <input checked="" type="checkbox"/> Müzakere <input checked="" type="checkbox"/>
Ön Koşullar	
İş Yeri Durumu	

Ders Kaynakları
<ul style="list-style-type: none"> • Required Text: <i>Computer Organization and Design: The Hardware/Software Interface</i> by David Patterson and John Hennessy (5th Edition) • Supplementary Readings: Selected research papers and articles

Ders Yapısı				
Matematik ve Temel Bilimler	<input type="checkbox"/>		Eğitim Bilimleri	<input type="checkbox"/>
Mühendislik Bilimleri	<input checked="" type="checkbox"/>		Fen Bilimleri	<input type="checkbox"/>
Mühendislik Tasarımı	<input type="checkbox"/>		Sağlık Bilimleri	<input type="checkbox"/>
Sosyal Bilimler	<input type="checkbox"/>		Alan Bilgisi	<input type="checkbox"/>

Haftalık Çizelge		
No	Konular	Dokümanlar/Notlar
1	Introduction to Computer Architecture <ul style="list-style-type: none"> • Overview of Computer Architecture and its importance • Evolution of computer systems • Basic structure and function of a computer Von Neumann architecture vs. Harvard architecture	Reviewing examples of related topics from the source book.
2	Computer Performance and Benchmarks <ul style="list-style-type: none"> • Measuring performance: execution time, throughput, latency 	Reviewing examples of related topics from the source book.

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	<ul style="list-style-type: none"> Factors affecting performance: clock cycles, cycle time, CPI Benchmarking and performance metrics: SPEC, MIPS, FLOPS Amdahl's Law	
3	Instruction Set Architecture (ISA) and Machine Language <ul style="list-style-type: none"> Introduction to ISA: what it is and why it's important Types of ISAs: CISC vs. RISC Instruction formats, addressing modes Machine language and assembly programming	Reviewing examples of related topics from the source book.
4	Arithmetic Logic Unit (ALU) Design <ul style="list-style-type: none"> Introduction to ALU and its role in CPU Binary arithmetic: addition, subtraction, multiplication, division Logical operations (AND, OR, XOR) Hardware implementation of basic operations	Reviewing examples of related topics from the source book.
5	Pipelining and Performance Enhancement <ul style="list-style-type: none"> Introduction to pipelining: stages, benefits, and challenges Instruction pipeline and pipeline hazards Clock cycle optimization Real-world examples of pipelined processors	Reviewing examples of related topics from the source book.
6	Hazards in Pipelining and Data Forwarding <ul style="list-style-type: none"> Structural, data, and control hazards Methods for resolving hazards: data forwarding, branch prediction Stalling and its impact on performance Example: pipeline implementation in modern processors	Reviewing examples of related topics from the source book.
7	Midterm Exam Review and Recap <ul style="list-style-type: none"> Review of Weeks 1–6 topics: ISA, ALU, pipelining, and performance Q&A session and sample problems Study guide and practice test	Reviewing examples of related topics from the source book.
8	Midterm Exam	Reviewing examples of related topics from the source book.
9	Memory Hierarchy: Caches, Virtual Memory <ul style="list-style-type: none"> Introduction to memory hierarchy: registers, cache, main memory 	Reviewing examples of related topics from the source book.

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	<ul style="list-style-type: none"> Cache design: cache mapping techniques, cache hits/misses Virtual memory and paging Performance implications of memory hierarchies	
10	Input/Output Systems and Buses <ul style="list-style-type: none"> Basics of I/O devices and their role in computer systems I/O performance metrics and optimization I/O interfacing and buses (PCI, USB) Direct Memory Access (DMA) and its role in improving performance	Reviewing examples of related topics from the source book.
11	Graphics Processing Units (GPUs) <ul style="list-style-type: none"> Introduction to GPUs and their architecture Difference between CPUs and GPUs Applications of GPUs in parallel computing and AI Performance and energy efficiency comparisons	Reviewing examples of related topics from the source book.
12	Power Efficiency and Advanced Architectures <ul style="list-style-type: none"> Power consumption in modern computer systems Energy-efficient processor design: clock gating, dynamic voltage scaling Modern advancements in computer architecture: quantum computing, neuromorphic computing	Reviewing examples of related topics from the source book.
13	Trends in Computer Architecture <ul style="list-style-type: none"> Current trends in CPU and GPU design Emerging technologies: cloud computing, edge computing, serverless architectures Advances in processor design for AI and machine learning workloads Future challenges in computer architecture	Reviewing examples of related topics from the source book.
14	Parallelism: Multiprocessors and Multithreading <ul style="list-style-type: none"> Introduction to parallelism and its importance in modern computing Shared memory multiprocessors vs. distributed memory Multithreading: hardware vs. software-level threads 	Reviewing examples of related topics from the source book.

MÜHENDİSLİK FAKÜLTESİ
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	Synchronization issues in parallel computing	
15	Final Exam Review	
16	Final Exam	

Değerlendirme Ölçütleri

Yarıyıl Çalışmaları	Sayı	Katkı Payı
Devam		%10
Laboratuvar		
Uygulama		
Alan Çalışması		%5
Derse Özgü İş Yeri Eğitimi		
Küçük Sınavlar/Stüdyo/Kritik		
Ödev		
Sunum		%5
Projeler		
Rapor		
Seminer		
Ara Sınavlar/Ara Jüri		%20
Genel Sınav/Final Jüri/Teslim		%60
Toplam		%100
Yarıyıl İçi Çalışmalarının Başarı Notu Katkısı		
Yarıyıl Sonu Çalışmalarının Başarı Notuna Katkısı		
Toplam		%100

AKTS/İş Yüğü Tablosu

Aktiviteler	Sayı	Süresi (Saat)	Toplam İş Yüğü
Ders Saati	16	3	48
Laboratuvar			
Uygulama			
Alan Çalışması			
Derse Özgü İş Yeri Eğitimi			
Sınıf Dışı Ders Çalışma Süresi	15	5	75
Küçük Sınavlar/Stüdyo/Kritik			
Ödev			
Sunum / Seminer Hazırlama	3	2	6
Projeler			
Rapor			
Ara sınav ve Ara Sınava Hazırlık	1	16	16
Genel Sınav ve Genel Sınava Hazırlık	1	30	30
Toplam İş Yüğü			175
Toplam İş Yüğü / 25			175/25
AKTS Kredisi			7

Ders Öğrenme Çıktıları

No	Açıklama
Ö1	Understand the fundamental concepts and architecture of computer systems including the distinctions between Von Neumann and Harvard architectures.
Ö2	Apply various performance measurement techniques and analyze computer performance using standard benchmarks such as SPEC, MIPS, and FLOPS.
Ö3	Demonstrate an understanding of instruction set architectures (ISA), including differences between RISC and CISC, and explain how instruction formats and addressing modes affect CPU operation.
Ö4	Design and implement basic arithmetic operations and logical circuits, focusing on binary arithmetic (addition, subtraction, multiplication, division) and logical operations (AND, OR, XOR) for CPU design.
Ö5	Identify, analyze, and resolve data, control, and structural pipeline hazards to optimize processor throughput and performance.

Ders Öğrenme Çıktılarının Program Öğrenme Çıktılarına Katkısı

Katkı Düzeyi: 1: Çok Düşük, 2: Düşük, 3: Orta, 4: Yüksek, 5: Çok Yüksek

	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	Toplam
Ö1	5	5	5	5												20
Ö2	5	5	5	5												20
Ö3	5	5	5	5												20
Ö4	5	5	5	5												20
Ö5	5	5	5	5												20
Toplam																100