	CS 233		CS 240		CS 241	
Programming						
MIPS	✓	Many MPs / Labs	--		--	
C	✓	Option for Many Labs	✓	MP1, MP2, MP3, MP3.2	✓	All MPs and Labs
C++	✓	Option for Many Labs	--		--	
Python	--		✓	MP4, MP5, MP5.2, MP6, Project	--	
Bash	--		✓	MP5.2 (docker)	✓	Lecture #30
Compiler Preprocessor	--		--		✓	Lecture #2
git	✓	All Assignments	✓	All Assignments	✓	All Assignments
Verilog	✓	Early MPs / Labs	--		--	
Data Representation						
Binary	✓	Lecture #2	✓	Lecture #2	--	
Hex	✓	Lecture #2	✓	Lecture #2	--	
Two's Complement	✓	Lecture #2	✓	Lecture #4	--	
Byte Order	✓	Lecture #7	✓	Lecture #15	✓	Lecture #33
Endianness	✓	Lecture #7	✓	Lecture #15	--	
ASCII	--		✓	Lecture #2	--	
Unicode / UTF-8	--		✓	Lecture #2	--	
File Extensions	--		✓	Lecture #3	--	
Chunk-Based Encoding	--		✓	Lecture #3	--	
Serealization	--		--		✓	Lecture #37
Circuits / Bit Manipulation						
Boolean Logic	✓	Lecture #1	✓	Lecture #4	--	
Bitwise Operators	✓	Lecture #1	✓	Lecture #4	--	
AND Gate	✓	Lecture #1	✓	Lecture #4	--	
OR Gate	✓	Lecture #1	✓	Lecture #4	--	
XOR Gate	✓	Lecture #1	✓	Lecture #5	--	
NOT Gate	✓	Lecture #1	✓	Lecture #4	--	
Truth Tables	✓	Lecture #2	✓	Lecture #4	--	
Binary Addition	✓	Lecture #2	✓	Lecture #4	--	
Bitshift Operators	✓	Lecture #2	✓	Lecture #4	--	
Half Adder	✓	Lecture #3	✓	Lecture #5	--	
Full Adder	✓	Lecture #3	✓	Lecture #5	--	
Ripple Carry Adder	✓	Lecture #3	✓	Lecture #5	--	
Multiplexers	✓	Lecture #3	--		--	

ALU	✓	Lecture #3	--		--	
Flip-flops	✓	Lecture #4	--		--	
Finite State Machines	✓	Lecture #4	--		--	
Registers	✓	Lecture #5	--		--	
Reigster Files	✓	Lecture #5	--		--	
Circuit Propagation Delay	✓	Lecture #5	--		--	
RAM	✓	Lecture #5	✓	Lecture #5	--	
Bianry Multiplication	✓	Lecture #6	✓	Lecture #4	✓	Lecture #1

CPU

Instruction Set Architectures (ISAs)	✓	Lecture #7	✓	Lecture #1	--	
Instruction Memory	✓	Lecture #7	--		--	
Control Instructions	✓	Lecture #8	--		--	
Load Upper Immediate (LUI)	✓	Lecture #8	--		--	
LOAD/STORE Pipeline	✓	Lecture #9	--		--	
CPU Registers	✓	Lecture #10	--		--	
Register Naming Conventions	✓	Lecture #10	--		--	
Programming Registers	✓	Lecture #10	--		--	
Function Call	✓	Lecture #11	--		--	
Caller Save Functions	✓	Lecture #11	--		--	
Caller Save Functions	✓	Lecture #11	--		--	
Hardware Interrupts	✓	Lecture #13	--		--	
Hardware Exceptions	✓	Lecture #13	--		--	
CPU Registers	✓	Lecture #14	--		--	
Iron Law of Computing	✓	Lecture #14	--		--	
Pipelining	✓	Lecture #16	--		--	
Stalls and Flushes	✓	Lecture #17	--		--	
CPU Caches	✓	Lecture #20	--		--	
Direct-Mapped Caches	✓	Lecture #20	--		--	
Set Associativie Caches	✓	Lecture #21	--		--	
Cache Prefetching	✓	Lecture #23	--		--	
TLB	✓	Lecture #26	--		--	

Memory Management

Memory Access Patterns	✓	Lecture #22	✓	Lecture #5	--	
Memory Hierarchy:	--		✓	Lecture #5	--	
Locality of Reference	✓	Lecture #24	✓	Lecture #6	--	
Virtual Memory	✓	Lecture #26	✓	Lecture #6	✓	Lecture #21
Segmentaiton	--		✓	Lecture #6	--	
Heap Memory Allocation	--		✓	Lecture #7	✓	Lecture #1
Pointers	✓	Lecture #12	✓	Lecture #7	✓	Lecture #3
Pointer Arithmetic	--		--		✓	Lecture #3
malloc specifics	--		✓	Lecture #7	✓	Lecture #8
Memory Coalescing	--		✓	Lecture #8	✓	Lecture #9

Free Lists	--	✓ Lecture #8	✓ Lecture #9
Buffer Overflow	--	--	✓ Lecture #10
Memory Pools	--	--	✓ Lecture #10
Memory Byte/Word Alignment	--	--	✓ Lecture #10
Page Tables	--	✓ Lecture #9	✓ Lecture #21
Page Table Index and Offset Bits	--	✓ Lecture #9	--
Page Table Sizes	--	✓ Lecture #9	--
Multi-level Page Tables	--	✓ Lecture #9	--
Virtual Pages	--	✓ Lecture #9	--
Page Faults	--	✓ Lecture #9	--
Optimal Page Replacement	--	✓ Lecture #9	--
Page Replacement Schemes	--	✓ Lecture #9	--
Segmentaiton Fault	--	✓ Lecture #9	--

OS, Threads, and Processes

POST / EFI	--	✓ Lecture #10	--
Bootloader	--	✓ Lecture #10	--
init process	--	✓ Lecture #10	--
Processes	--	✓ Lecture #10	✓ Lecture #6
Context Switching	--	✓ Lecture #10	--
fork-exec-wait Pattern	--	--	✓ Lecture #6
Environmental Variables	--	✓ Lecture #16	✓ Lecture #5
Signals	--	--	✓ Lecture #7
Singal Masking	--	--	✓ Lecture #35
Threads	--	✓ Lecture #10	✓ Lecture #11
Thread Start	--	✓ Lecture #12	✓ Lecture #11
Thread Join	--	✓ Lecture #12	✓ Lecture #11
Thread Parallelism	--	✓ Lecture #12	✓ Lecture #11
Processes vs. Threads	--	✓ Lecture #12	✓ Lecture #11
Blocking Operations	--	✓ Lecture #12	✓ Lecture #14
User Accounts	--	✓ Lecture #17	--

Sync

Critical Section	--	✓ Lecture #13	✓ Lecture #13
Mutex Locks	--	✓ Lecture #12	✓ Lecture #13
Race Conditions	--	✓ Lecture #13	✓ Lecture #14
Conditional Variables	--	--	✓ Lecture #15
Semaphores	--	--	✓ Lecture #16
Barrier	--	--	✓ Lecture #18
Producer/Consumer Model	--	--	✓ Lecture #17
Readers-Writers Problem	--	--	✓ Lecture #17
Deadlock	--	✓ Lecture #13	✓ Lecture #18
Coffman Conditions	--	✓ Lecture #13	✓ Lecture #19
Resource Allocation Grpahs	--	--	✓ Lecture #19

Llivelock	--	✓ Lecture #13	✓ Lecutre #20
Dining Philosophers	--	✓ Lecture #13	✓ Lecutre #20
IPC			
Pipes	--	✓ Lecture #10	✓ Lecutre #22
mmap	--	R "Shared Memory" IPC	✓ Lecutre #21
I/O Multiplexing	--	--	✓ Lecutre #33
RPC	--	✓ Lecture #10	✓ Lecutre #37
Networking			
OSI Model	--	✓ Lecture #14	--
IP / IP Addresses	--	✓ Lecture #14	--
TCP	--	✓ Lecture #14	✓ Lecutre #25
TCP Handshake	--	✓ Lecture #14	✓ Lecutre #37
UDP	--	✓ Lecture #14	✓ Lecutre #25
HTTP	--	✓ Lecture #11	✓ Lecutre #25
HTTP Status Codes	--	✓ Lecture #11	--
HTTP Verbs	--	✓ Lecture #19	--
Raw Sockets	--	--	✓ Lecutre #26
Denial of Service (DoS)	--	--	✓ Lecutre #36
Ports	--	✓ Lecture #16	--
Domain Name Service	--	✓ Lecture #20	--
FQDN	--	✓ Lecture #20	--
DNS Root Servers	--	✓ Lecture #20	--
DNS Records	--	✓ Lecture #20	--
CDNs	--	✓ Lecture #20	--
File Systems and Disks			
File I/O	--	--	✓ Lecture #4
Circular Buffer	--	--	✓ Lecture #16
File Seek	--	--	✓ Lecutre #22
inodes	--	--	✓ Lecutre #27
direct blocks	--	--	✓ Lecutre #27
indirect blocks	--	--	✓ Lecutre #27
Linux Permission Bits	--	--	✓ Lecutre #28
Symbolic Links	--	--	✓ Lecutre #29
Hard Links	--	--	✓ Lecutre #29
Hidden Files	--	--	✓ Lecutre #29
Sticky Bit	--	--	✓ Lecutre #29
RAID	--	--	✓ Lecutre #31
HDDs (Spinning Disks)	--	--	✓ Lecutre #34
SSDs	--	--	✓ Lecutre #34

Scheduling

CPU Scheduling	--		--	✓	Lecture #32
FIFO	--		--	✓	Lecture #32
EDF	--		--	✓	Lecture #32
Round Robin	--		--	✓	Lecture #32
Starvation	--		--	✓	Lecture #32

Systems Architecture

Monolithic	--	✓	Lecture #16	--	
Microservice	--	✓	Lecture #16	--	
User Account Isolation	--	✓	Lecture #17	--	
Containerization	--	✓	Lecture #17	--	
Virtualization	--	✓	Lecture #17	--	
MapReduce	--	✓	Lecture #19	--	
Data Store: Local Memory	--	✓	Lecture #21	--	
Data Store: File-Backed Storage	--	✓	Lecture #21	--	
Data Store: Key-Value Store	--	✓	Lecture #21	--	
Data Store: NoSQL Databases	--	✓	Lecture #21	--	
Data Store: SQL Databases	--	✓	Lecture #21	--	
DIY / Self-Hosted	--	✓	Lecture #21	--	
Infrastructure as a Service	--	✓	Lecture #21	--	
IaaS: EC2 / GCP	--	✓	Lecture #21	--	
Platform as a Service	--	✓	Lecture #21	--	
PaaS: Docker	--	✓	Lecture #21	--	
Software as a Service	--	✓	Lecture #21	--	
SaaS: CDN	--	✓	Lecture #21	--	

Containerization and Virtualization

Container Technology	--	✓	Lecture #18	--	
Docker	--	✓	Lecture #18	--	
Dockerfile	--	✓	Lecture #18	--	
Docker Image Hierarchy	--	✓	Lecture #18	--	
Container File System Mounts	--	✓	Lecture #18	--	
Container Port Forwarding	--	✓	Lecture #18	--	

Applicaiton Interfaces

API Overview	--	✓	Lecture #19	--	
RESTful APIs	--	✓	Lecture #19	--	
Stateful APIs	--	✓	Lecture #19	--	
Frontend Services	--	✓	Lecture #22	--	
Middleware Services	--	✓	Lecture #22	--	
Backend Services	--	✓	Lecture #22	--	
Common Web Server Stacks	--	✓	Lecture #22	--	