

# CSGE602055 Operating Systems

## CSF2600505 Sistem Operasi

### Week 08: Scheduling

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<https://os.vlsm.org/>

Always check for the latest revision!

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# Operating Systems 2019-2

A/M (Rm 3114) [Tu/Th 08-10] — I (Rm A7.14) [Tu 13-15/Th 14-16]

Week	Schedule	Topic	OSC10
Week 00	03 Sep - 09 Sep 2019	Overview 1, Virtualization & Scripting	Ch. 1, 2, 18.
Week 01	10 Sep - 16 Sep 2019	Overview 2, Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	17 Sep - 23 Sep 2019	Security, Protection, Privacy, & C-language	Ch. 16, 17
Week 03	24 Sep - 30 Sep 2019	File System & FUSE	Ch. 13, 14, 15
Week 04	01 Oct - 07 Oct 2019	Addressing, Shared Lib, & Pointer	Ch. 9
Week 05	08 Oct - 14 Oct 2019	Virtual Memory	Ch. 10
Reserved	15 Oct - 18 Oct 2019	Q & E	
MidTerm	19 Oct - 25 Oct 2019	TBA — MidTerm (UTS)	
Week 06	29 Oct - 04 Nov 2019	Concurrency: Processes & Threads	Ch. 3, 4
Week 07	05 Nov - 11 Nov 2019	Synchronization & Deadlock	Ch. 6, 7, 8
Week 08	12 Nov - 18 Nov 2019	Scheduling + W06/W07	Ch. 5
Week 09	19 Nov - 25 Nov 2019	Storage, Firmware, Bootldr, & Systemd	Ch. 11
Week 10	26 Nov - 02 Dec 2019	I/O & Programming	Ch. 12
Reserved	03 Dec - 13 Dec 2019	Q & E	
Final Extra	14 Dec - 21 Dec 2019 09 Jan 2020	TBA — Final (UAS) Extra assignment confirmation	This schedule is subject to change.

# STARTING POINT — <https://os.vlsm.org/>

- ❑ **Text Book** — Any recent/decent OS book. Eg. (**OSC10**) Silberschatz et. al.: **Operating System Concepts**, 10<sup>th</sup> Edition, 2018. See also <http://codex.cs.yale.edu/avi/os-book/OS10/>.
- ❑ **Weekly**
  - ❑ Encode your **QRC** with size about 5cm x 5cm (ca. 400x400 pixels):  
**"OS192 CLASS ID SSO-ACCOUNT Your-Full-Name"**  
Write your Memo (with QRC) **every week**.  
See also Assignment#0: Generate your QR Code.
  - ❑ Login to [badak.cs.ui.ac.id](http://badak.cs.ui.ac.id) via [kawung.cs.ui.ac.id](http://kawung.cs.ui.ac.id) for at least **10 minutes** every week. Copy all weekly demo folders into your own badak home directory.  
Eg.: `cp -r /extra/Demos/ .`
- ❑ **Resources**
  - ❑ **All In One** — [BADAK.cs.ui.ac.id:///extra/](http://BADAK.cs.ui.ac.id:///extra/) (**FASILKOM only!**).
  - ❑ **Download Slides and Demos from GitHub.com**  
<https://github.com/UI-FASILKOM-OS/SistemOperasi/>
  - ❑ **Problems** — <https://rms46.vlsm.org/2/>:  
195.pdf (W00), 196.pdf (W01), 197.pdf (W02), 198.pdf (W03),  
199.pdf (W04), 200.pdf (W05), 201.pdf (W06), 202.pdf (W07),  
203.pdf (W08), 204.pdf (W09), 205.pdf (W10).

# Agenda

- 1 Start
- 2 Schedule
- 3 Agenda
- 4 Week 08
- 5 Scheduling
- 6 CPU Burst: How Long (When)?
- 7 MultiProcessor Scheduling
- 8 The Two State Model
- 9 The End

# Week 08 Scheduling: Topics<sup>1</sup>

- Preemptive and non-preemptive scheduling
- Schedulers and policies
- Processes and threads
- Deadlines and real-time issues

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 08 Scheduling: Learning Outcomes<sup>1</sup>

- Compare and contrast the common algorithms used for both preemptive and non-preemptive scheduling of tasks in operating systems, such as priority, performance comparison, and fair-share schemes. [Usage]
- Describe relationships between scheduling algorithms and application domains. [Familiarity]
- Discuss the types of processor scheduling such as short-term, medium-term, long-term, and I/O. [Familiarity]
- Describe the difference between processes and threads. [Usage]
- Compare and contrast static and dynamic approaches to real-time scheduling. [Usage]
- Discuss the need for preemption and deadline scheduling. [Familiarity]
- Identify ways that the logic embodied in scheduling algorithms are applicable to other domains, such as disk I/O, network scheduling, project scheduling, and problems beyond computing. [Usage]

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<sup>1</sup>Source: ACM IEEE CS Curricula 2013

# Week 08: Scheduling

- Reference: (OSC10-ch05 demo-w08)
- Scheduling
  - Basic Concepts
    - **WARNING:** It's just a BURST
    - IO Burst
    - CPU Burst
    - CPU Burst vs. Freq (See next slide)
  - Criteria: Utilization, throughput, {turnaround, waiting, response} time.
  - (Burst) Algorithm
    - FCFS, SJF, RR, Priority, Multilevel Queue.
  - Preemptive / Non-preemptive (Cooperative) Scheduling
  - I/O Bound / CPU Bound Processes
- Thread Scheduling
  - User-level → Process-Contention Scope (PCS): many to many/one.
  - Kernel-level → System-Contention Scope (SCS): one to one.
- Standard Linux Scheduling
  - Completely Fair Scheduler (CFS).
  - Real Time Scheduling.

# CPU Burst: How Long (When)?



©2013 Silberschatz, Galvin and Gagne Operating System Concepts – 9<sup>th</sup> Edition



# MultiProcessor Scheduling

- Asymmetric Multiprocessing vs. Symmetric Multiprocessing (SMP).
- Processor Affinity: soft vs. hard.
- NUMA: Non-Uniform Memory Access.
- Load Balancing
- Multicore Processors
- Real Time Scheduling: Soft vs. Hard.
- Big O Notation
  - $O(1)$
  - $O(\log N)$
  - $O(N)$

# The Two State Model

- CPU State – I/O State – CPU State – ...
  - $n$ : processes in memory.
  - $p$ : I/O time fraction.
  - $p^n$ : probability  $n$  processes waiting for I/O.
  - $1 - p^n$ : CPU utilization of  $n$  processes.
  - $\left[ \frac{(1-p^n)}{n} \right]$ : CPU utilization of ONE processes.
- Example:  $p = 60\% \Rightarrow$  **CPU Utilization Per Process:**  $\left[ \frac{1-(60\%)^n}{n} \right]$

CPU Utilization	Multiprogramming (%)				
N	1	2	3	4	5
Per Process	40	32	26	21	18

- For 5 concurrent processes:  
If total time is 100 seconds; for each process, the CPU time will be 18 seconds.

# The End

- ☐ This is the end of the presentation.
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