

# CSGE602055 Operating Systems

## CSF2600505 Sistem Operasi

### Week 08: Scheduling

Rahmat M. Samik-Ibrahim (ed.)

University of Indonesia

<https://os.vlsm.org/Slides/os08.pdf>

Always check for the latest revision!

REV337 30-Aug-2021

# OS212<sup>3</sup>): Operating Systems 2021 - 2

OS A	OS B	OS C	OS INT
Every first day of the Week, <b>Quiz#1</b> and <b>Quiz#2</b> : 07:15-08:00			
Monday/Thursday 13:00 — 14:40	Monday/Thursday 15:00 - 16:40	Monday/Thursday 13:00 — 14:40	Monday/Wednesday 08:00 — 09:40

Week	Schedule & Deadline <sup>1)</sup>	Topic	OSC10 <sup>2)</sup>
Week 00	30 Aug - 05 Sep 2021	Overview 1, Virtualization & Scripting	Ch. 1, 2, 18.
Week 01	06 Sep - 12 Sep 2021	Overview 2, Virtualization & Scripting	Ch. 1, 2, 18.
Week 02	13 Sep - 19 Sep 2021	Security, Protection, Privacy, & C-language.	Ch. 16, 17.
Week 03	20 Sep - 26 Sep 2021	File System & FUSE	Ch. 13, 14, 15.
Week 04	27 Sep - 03 Oct 2021	Addressing, Shared Lib, & Pointer	Ch. 9.
Week 05	04 Oct - 10 Oct 2021	Virtual Memory	Ch. 10.
Week 06	11 Oct - 17 Oct 2021	Concurrency: Processes & Threads	Ch. 3, 4.
Week 07	01 Nov - 07 Nov 2021	Synchronization & Deadlock	Ch. 6, 7, 8.
Week 08	08 Nov - 14 Nov 2021	Scheduling + W06/W07	Ch. 5.
Week 09	15 Nov - 21 Nov 2021	Storage, Firmware, Bootloader, & Systemd	Ch. 11.
Week 10	22 Nov - 28 Nov 2021	I/O & Programming	Ch. 12.

<sup>1)</sup> The **DEADLINE** of Week 00 is 05 Sep 2021, whereas the **DEADLINE** of Week 01 is 12 Sep 2021, and so on...

<sup>2)</sup> Silberschatz et. al.: **Operating System Concepts**, 10<sup>th</sup> Edition, 2018.

<sup>3)</sup> This information will be on **EVERY** page two (2) of this course material.

# 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 <https://www.os-book.com/OS10/>.
- ❑ **Resources**
  - ❑ **SCELE OS212** — <https://scele.cs.ui.ac.id/course/view.php?id=3268>.  
The enrollment key is **XXX**.
  - ❑ **Download Slides and Demos from GitHub.com**  
<https://github.com/UI-FASILKOM-OS/SistemOperasi/>:  
[os00.pdf \(W00\)](#), [os01.pdf \(W01\)](#), [os02.pdf \(W02\)](#), [os03.pdf \(W03\)](#),  
[os04.pdf \(W04\)](#), [os05.pdf \(W05\)](#), [os06.pdf \(W06\)](#), [os07.pdf \(W07\)](#),  
[os08.pdf \(W08\)](#), [os09.pdf \(W09\)](#), [os10.pdf \(W10\)](#).
  - ❑ **Problems**  
[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 \(W10\)](#).
  - ❑ **LFS** — <http://www.linuxfromscratch.org/lfs/view/stable/>
  - ❑ **OSP4DISS** — <https://osp4diss.vlsm.org/>
  - ❑ **DOIT** — <https://doit.vlsm.org/001.html>

# 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 Week 08: Check List
- 10 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

---

<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]

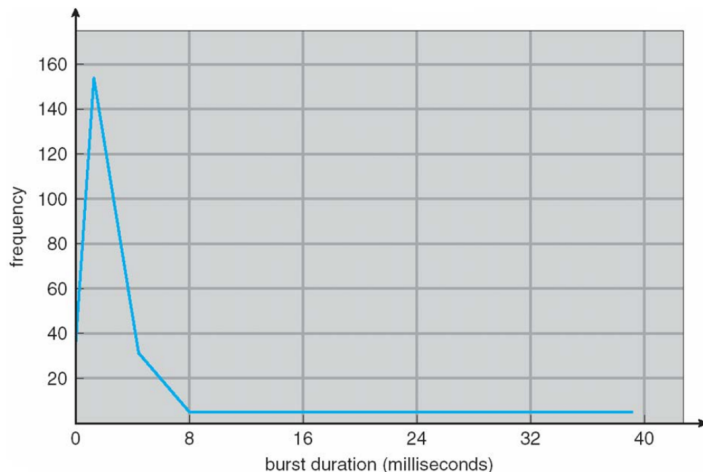
---

<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

Figure: Burst: Duration vs Frequency



# 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.

# Week 08: Check List (Deadline: 14 Nov 2021).

- ☐ Week 08 Token: AkunGitHubW08 Eg. **cbkadalW08**
- ☐ This page is <https://os.vlsm.org/Slides/check08.pdf>.
- ☐ More details: <https://osp4diss.vlsm.org/W08.html>.
- ☐ Assignment Check List:
  - ① Read: (OSC10 chapter 05)
  - ② Visit <https://os.vlsm.org/GitHubPages/>. Review **Last Week TOP 10 List** and pick at least 3 out of your 10 next neighbors. See <https://cbkadal.github.io/os212/TXT/myrank.txt>. item Create your **TOP 10 List** of Week 08. **Do not use lecture material. Please be more creative!** (E.g. <https://cbkadal.github.io/os212/W08/>).
  - ③ Week 08 - 10 will be about building "Linux From Scratch (LFS)"
  - ④ There will be no download. The result of each week should be placed into a "W08/" folder and tarballed as "myW08.tar.bz2.asc"
  - ⑤ Update your log (e.g. <https://cbkadal.github.io/os212/TXT/mylog.txt>).
  - ⑥ Make **SHA256SUM** and sign it (detached, armor) as **SHA256SUM.asc**.

# The End

- ☐ This is the end of the presentation.
- ☒ This is the end of the presentation.
  - This is the end of the presentation.