(1) What are the two primary roles of operating systems?

- Operating systems as *middlemen* between high-level commands (human users or user applications) or operating systems as *extended machines* (+5 points)

- Operating systems as *government* for system resources in a computer systems or operating systems as *resource managers* (+5 points)

(2) What are the typical three structural layers in a computer system?

They are: ① application layer  
② OS layer  
③ Hardware layer

(3) What is “context switching”?

The context switching is the act of switching a processor from one program (process) to another by saving the processor registers of the current process to the stack and loading the processor registers of the next process from the stack.
(4) What was the primary disadvantage and advantage in “Pre Operating System (no OS)”?
Mention at least (primary) one for each of the primary disadvantage and advantage.

**Disadvantages (any one of the followings):**

- Requires human users to attend with the computer system they use
- Poor processor utilization

**Advantage:**

- User programs can use all the hardware resources available (therefore, user programs run fast)

(5) What problem in “batch system” do “multi-programming (multitasking) OSes” fix and how? (note: this question consists of two questions – make sure to provide a solution for each (“what” and “how”)?

The problem multitasking OSes fix is “low processor utilization*”. Multitasking operating systems improve processor utilization by loading multiple programs into memory and whenever the current process does not use the processor, the processor is switched to another program that needs a processor.

*: Since batch systems execute one program at a time, its processor utilization is usually low (as we discussed in the classroom.

**Note:** “the capability to fix bugs after a program crashes by a software bus” is not the problem “multitasking OS” fixes. It is the problem “timesharing systems (timesharing multitasking OSes) fix.