

Instructions: There are **three** questions which count 100 points in total. Each question may have several sub-questions. Please read the questions thoroughly before answering.

1. Process Management (38 points)
 - A. (8 points) What is the difference between “multi-threading” and “multi-process”? Please discuss the robustness and performance in these two modes.
 - B. (12 points) Consider several operating systems deployed over a virtual machine software such as VirtualBox and VMWare. Please briefly describe the procedure for a task that runs over an operating system to receive a Ctrl-C signal from keyboard.
 - C. (8 points) Please describe the procedures on preventing a processing from being preempted by operating system on single processor systems and multiple processors systems.
 - D. (10 points) Consider round-robin scheduling and scheduling criteria being “average waiting time”. Will the response time of each process becomes shorter with a smaller time quantum? You must explain why.

2. (20 points) Memory management:
 - A. (8 points) Please explain the cause of internal and external fragmentation.
 - B. (6 points) If LRU page replacement is used with three page frames and eight pages, how many page faults will occur with the reference string 271321037 if the four frames are initially empty?
 - C. (6 points) If Aging page replacement is used with three page frames and eight pages, how many page faults will occur with the reference string 271321037 if the four frames are initially empty?

3. (42 points) When using a distributed file system, the server may be either stateless or stateful.
 - A. (10 points) Please give a short description for stateless and stateful distributed file server.
 - B. (12 points) Please describe the impact of each of these two mechanisms when the file server crashes and recovers later.
 - C. (20 points) Please describe the procedure to support file access without always being connected to file server for both stateful and stateless file server.