CENG322 Final Exam - Spring 2021
(90 minutes)

Q.1 (15 Points) Consider a virtual memory system with 34-bit addresses. The first 23 bits are used as a page number and the last 11 bits is the offset. (Note that $2^{10}= 1K$, $2^{20} = 1M$)

a) (5 Points) How many Kilobytes (KB) is a single page frame?

2^{23} entries, 2^{11} bytes – one frame=2^{11} bytes = 2KB

b) (10 Points) Assuming the single-level paging and each page-table entry to be 4 bytes, how many Megabytes of memory is needed to store the page table?

2^{23} entries, 4 bytes each – 2^{23} x 4 = 2^{25} bytes = 32 MB

Q.2 (40 Points) Answer the following questions. You will have no point unless you include explanations/examples in your answer.

a) When a process forks a child process, the child copies the address space of the parent process and continues by working in its own copy. Instead of <u>immediate</u> copy, propose an alternative way to optimize memory allocation.

Copy-on-write

b) In paging system, explain the benefit of the shared library functions by giving an example scenario.

Only one read-only memory space, page table maps to the same physical memory

c) In contiguous memory allocation method, explain the external fragmentation problem with an example scenario. Provide a solution by explaining your example case.

There is available space, but not contiguous

d) Explain the relationship between thrashing and multiprogramming in an example execution.

Multiprogramming (more processes) – more memory requirement – more page fault – less CPU utilization

Q.3 (20 Points) Consider the following set of processes, with the length of the CPU burst given in milliseconds. The processes are assumed to have arrived in the order P1, P2, P3, P4, all at time 0.

Process	Priority	Burst
P1	30	10
P2	20	35
P3	25	20
P4	60	25

Show the scheduling order of the processes using a Gantt chart for Shortest Job First (SJF), nonpreemptive priority (<u>a larger priority number implies a higher priority</u>), and RR (quantum = 10). Calculate the turnaround time for each process for each case.

SJF:

P1-P3-P4-P2
10, 90, 30, 55

Priority:

P4-P1-P3-P2
35, 90, 55, 25

RR:

P1-P2-P3-P4-P2-P3-P4-P2-P4-P2
10, 90, 60, 85

Q.4 (25 Points) Consider a paging system with the page table stored in memory.

a) (5 Points) If a memory reference takes 100 nanoseconds, how long does a paged memory reference take?

200

b) (10 Points) Can TLB decrease the memory access time? Justify your answer by giving an example.

Yes

c) (10 Points) Can multi-level paging decrease the memory access time? Justify your answer by giving an example.

No