THE UNIVERSITY OF ZAMBIA

SCHOOL OF NATURAL SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

CSC 2202 – INTRODUCTION TO OPERATING SYSTEMS

DURATION: 3 HOURS

DATE: 15TH SEPTEMBER, 2016

INSTRUCTIONS

- This paper has a total of seven questions
- You must answer a total of five (5) questions
    - Section A is compulsory for all
    - Section B has five (5) questions, attempt any three (3)
- All questions carry equal marks (20 marks each)
- Clearly number all your answers
- Use the marks as a guide to the detail required in your answers while keeping your answers concise and relevant

SECTION A (Answer all questions)

QUESTION 1 (20 marks)

A. Let's assume you have exactly three page frames and they contain the pages A, B, and C. Construct a page reference sequence of 10 page accesses, including A, B, C and any other pages you want demonstrating that MIN produces a better hit rate than does LRU. Include the hit rates for each algorithm. **[2marks]**

B. What are the three main purposes of an operating system? **[3 marks]**

C. A system is designed with the condition that no thread holding lock A can acquire lock B. What problem is this system designed to prevent? **[1 mark]**

D. What is the difference between a program (an executable file) and a process and how is a program transformed into a process? A process is an instantiation of a program. **[2 marks]**

E. Mrs. Kumar is playing with kittens. She throws out a yarn ball and the kittens all race to fetch it, but only one succeeds. There are 12 kittens. After playing with the ball for amoment, the kitten brings the yarn ball back, returns it to Professor Seltzer and gets a treat. Which of deadlock, race condition, or starvation can occur? Please explain. **[2 marks]**

F. Explain how a scheduling algorithm could produce good throughput, but poor response time. Then explain how a scheduling algorithm could produce good response time, but poor throughput. **[4 marks]**

G. State three advantages of placing functionality in a device controller, rather than in the kernel. State three disadvantages. **[6 marks]**

QUESTION 2 (20 marks)

A. Give two reasons why caches are useful. What problems do they solve? What problems do they cause? If a cache can be made as large as the device for which it is caching (for instance, a cache as large as a disk), why not make it that large and eliminate the device? **[5 marks]**

B. What are the five major activities of an operating system with regard to process management? **[5 marks]**

C. What are two differences between user-level threads and kernel-level threads? Under what circumstances is one type better than the other? **[6 marks]**

D. Some systems automatically delete all user files when a user logs off or a job terminates, unless the user explicitly requests that they be kept; other systems keep all files unless the user explicitly deletes them. Discuss the relative merits of each approach. **[4 marks]**

SECTION B (Choose any three)

QUESTION 3 (20 marks)

A. What are preemptive and non-preemptive scheduling policies? Elaborate your answer **[2 marks]**

B. Five processes A, B, C, D and E arrived in this order at the same time with thefollowing CPU burst and priority values. A smaller value means a higher priority **[12 marks]**

	CPU Burst	*Priority*
A	3	3
B	7	5
C	5	1
D	2	4
E	6	2

Fill the entries of the following table with waiting time and average waiting time for each indicated scheduling policy and each process. Ignore context switching overhead.

Scheduling Policy	*Waiting Time*					Average Waiting Time
	A	*B*	*C*	*D*	*E*	
First-Come-First-Served						
Non-Preemptive Shortest-Job First						
Priority						
Round-Robin (time quantum=2)						

Scheduling Policy	*Waiting Time*					*Average Waiting Time*
	A	*B*	*C*	*D*	*E*	
First-Come-First-Served	0	3	10	15	17	45/5 = 9
Non-Preemptive Shortest-Job First	2	16	5	0	10	33/5=6.6
Priority	11	16	0	14	5	46/5=9.2
Round-Robin (time quantum=2)	8	16	15	6	16	61/5=12.2

C. Describe the two general roles of an operating system, and elaborate why these roles areimportant. **[4 marks]**

D. What is a translation look-aside buffer? **[2 marks]**

QUESTION 4 (20 marks)

A. What are three requirements of any solution to the critical sections problem? Why are the requirements needed? **[6 marks]**

B. Describe the page replacement algorithms below. Critically compare them with each other **[4 marks]**

   i. Least Recently Used (LRU)

   ii. Clock

C. Explain why mobile operating systems such as iOS and Android do not support swapping? **[2 marks]**

D. Many CPU-scheduling algorithms are parameterized. For example, the Round Robin (RR) algorithm requires a parameter to indicate the time slice. Multilevel feedback queues require parameters to define the number of queues, the scheduling algorithms for each queue, the criteria used to move processes between queues, and so on.

These algorithms are thus really sets of algorithms (for example, the set of RR algorithms for all time slices, and so on). One set of algorithms may include another (for example, the First Come First Serve (FCFS) algorithm is the RR algorithm with an infinite time quantum).What (if any) relation holds between the following pairs of algorithm sets? **[8 marks]**

   i. Priority and SJF

   ii. Multilevel feedback queues and FCFS

   iii. Priority and FCFS

   iv. RR and SJF

QUESTION 5 (20 marks)

A. Device controllers are generally becoming more complex in the functionality they provide (e.g. think about the difference between implementing a serial port with a flip-flop controlledby the CPU and a multi-gigabit network adapter with the TCP/IP stack on the card itself).What effect might this have on the operating system and system performance? **[2 marks]**

B. Consider a logical address space of 32 pages of 2048 words each, mapped onto a physical memory of 8 frames. **[8 marks]**

   i. How many bits are needed for addressing the total logical address?
   ii. How many bits are needed to indicate the page number?
   iii. How many bits are needed for addressing the physical address?
   iv. What is the effect of allowing more than one entry in a page table (each entry belongs to a process) to point to the same frame in physical memory?

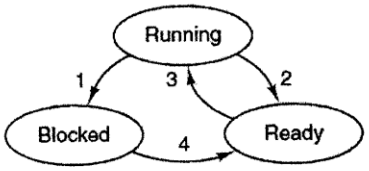
C. Why do some systems keep track of the type of a file, while others leave it to the user and others simply do not implement multiple file types? Which system is "better?" **[5 marks]**

D. How does DMA increase system concurrency? How does it complicate hardware design? **[3 marks]**

E. What are the major benefits of using threads other than responsiveness? **[2 marks]**

QUESTION 6

A. Describe the three state process model, describe what transitions are valid between thethree states, and describe an event that might cause such a transition. **[7 marks]**



1. Process blocks for input
2. Scheduler picks another process
3. Scheduler picks this process
4. Input becomes available

B. What is a critical region? How do they relate to controlling access to shared resources?

[4 marks]

C. Suppose that a 10-MB file is stored on a disk on the same track (track 50) in consecutive sectors. The disk arm is currently situated over track number 100. How long will it take to retrieve this file from the disk? Assume that it takes about 1 ms to move the arm from one cylinder to the next and about 5 ms for the sector where the beginning of the file is stored to rotate under the head. Also, assume that reading occurs at a rate of 200 MB/s.

[5 marks]

D. Why is it important to scale up system-bus and device speeds as CPU speed increases?

[4 marks]

QUESTION 7

A. The readers and writers problem can be formulated in several ways with regard towhich category of processes can be started when. Carefully describe ***three*** differentvariations of the problem, each one favoring (or not favoring) some category of processes.For each variation, specify what happens when a reader or a writer becomesready to access the database, and what happens when a process is finished. **[6 marks]**

B. Two computer science students, Keziah and Haward, are having a discussion about inodes. Bwalya maintains that memories have gotten so large and so cheap that when afile is opened, it is simpler and faster just to fetch a new copy of the i-node into the inodetable, rather than search the entire table to see if it is already there. Haward disagrees. Who is right and why?

[4 marks]

C. A typical printed page of text contains 50 lines of 80 characters each. Imagine that acertain printer can print 6 pages per minute and that the time to write a character to theprinter's output register is so short it can be ignored. Does it make sense to run thisprinter using interrupt-driven I/O if each character printed requires an interrupt thattakes 50 μ sec all-in to service?

[5 marks]

D. In which of the four I/O software layers is each of the following done. **[2 marks]**

   a. Computing the track, sector, and head for a disk read.
   b. Writing commands to the device registers.
   c. Checking to see if the user is permitted to use the device.
   d. Converting binary integers to ASCII for printing.

E. RAID level 3 is able to correct single-bit errors using only one parity drive. What is thepoint of RAID level 2? After all, it also can only correct one error and takes moredrives to do so.

[3 marks]

END OF EXAM

All the best!!!