Question 1

Write a complete C program using the pthread_create() system call that sorts a given n-element array of integers in ascending order using the quicksort method. n is a positive integer supplied by the user and the parent thread generates an array of n random integers. The array will be sorted by the child thread. The sorted array will be output by the parent thread. Have the parent thread invoke the pthread_join() system call to wait for the child thread to finish the sorting task. Perform necessary error checking to ensure that a positive integer n is passed on the command line.

Question 2

Consider the following set of five processes P_1, P_2, P_3, P_4, and P_5. The priorities and the lengths of the CPU-burst time in milliseconds are given below.

Process	Burst Time	Priority
P_1	15	5
P_2	3	2
P_3	9	1
P_4	6	4
P_5	4	3

The processes are assumed to have arrived in the order P_1, P_2, P_3, P_4, P_5, all at time 0.
A larger priority number implies a higher priority.
Draw a Gantt chart illustrating the execution of these processes and compute the average waiting time (AWT) of each of the following CPU scheduling algorithms.

(a) FCFS
(b) Non-preemptive Shortest Job First
(c) Non-preemptive priority scheduling
(d) Round robin with a 5ms time quantum

Question 3

A computer has four page frames. The time of loading, time of last access, and the R(reference) bit for each page are as shown below. The times are in clock ticks:

page	loaded	last ref.	R
0	140	270	0
1	110	285	1
2	126	280	1
3	230	265	0

For each of the following page replacement algorithms, determine which page will be replaced:

(i) Second Chance [2 marks]
(ii) LRU [1 mark]
(iii) CLOCK [2 marks]

Question 4

(a) Given that main memory is 64K, a page/frame size is 4K and that a process's virtual memory size is 128K.
    (i) How many entires would a page table in this system contain?
    (ii) What is the size of the virtual address and a real memory address in this system?
    (iii) Explain how the memory management unit converts a virtual address into an address in real memory on this system.

(b) In a virtual memory management system, under what conditions are inverted page tables needed? How is such a table used?

Please ignore the marks listed next to the questions.

Submission Instructions:

- Work in groups of 5
  - form your own groups and submit one assignment per group
  - Ensure each student name and ID is clearly stated on a cover page
- Implement your program for question 1 on a UNIX like platform such as Ubuntu Linux.
- The source code must be appropriately commented and structured to allow users to understand your code
- Upload a zipped file containing your solutions to myelearning before the deadline.
- Absolutely no late submissions