UNIVERSITY OF ESWATINI

FACULTY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

Main Examination

Course Name: Modern Operating Systems / Operating Systems

Course Code: CS442/ CSC 322

Time allowed: **Three (3)** Hours

INSTRUCTIONS TO THE CANDIDATES
1) Answer any **four (4)** questions out of the **five (5)** questions.
2) Each question carries **twenty-five (25)** marks.
3) This examination paper should **NOT** be opened until permission has been granted by the invigilator.
4) This examination consists of **three (3)** printed pages.
5) Number of marks per each question is written at the end of each question

Question 1

a) With the aid of diagrams, compare and contrast any three (3) approaches to Operating System structure. [9 marks]

b) How does the distinction between kernel mode and user mode function as a rudimentary form of protection (security) system? [4 marks]

c) In a multiprogramming and time-sharing environment, several users share the system simultaneously. This situation can result in various security problems.

    i) What are two such problems? [2 marks]

    ii) Can we ensure the same degree of security in a time-shared machine as in a dedicated machine? Explain your answer. [5 marks]

d) Process scheduling can be pre-emptive or non-preemptive. With the aid of relevant examples, compare and contrast these approaches. [5 marks]

Question 2

A small computer has three page frames in the RAM. Initially, there are no pages in the main memory, and subsequently the following reference string occurs:

$$0,2,4,3,1,0,2,3,5,3,2,0,4,1,2$$

What are the contents of main memory (RAM) and determine the total number of page faults of each of the following Page Replacement algorithms:

    (i) First in First Out (FIFO).

    (ii) Least Recently Used (LRU).

    (iii) Optimal page replacement algorithm. [25 marks]

Question 3

a) Describe four (4) goals of Operating system security. [8 marks]

b) Microsoft Corporation developed a threat modelling framework called **STRIDE** Model to classfity system threats. Critically analyse the applicability of STRIDE model in healthcare sector in the Kingdom of Eswatini. [17 marks]

Question 4

a) Describe any two models of Inter Process communication. [6 marks]

b) With the aid of diagrams, explain three types of multi-threading models. [9 marks]

c) Considering a system with five processes P_0 through P_4 and three resources types **A, B, C**. Resource type A has 10 instances, B has 5 instances and type C has 7 instances. Suppose at time t_0 following snapshot of the system has been taken:

Process	Allocation	Max	Available
	A B C	A B C	A B C
P_0	0 1 0	7 5 3	3 3 2
P_1	2 0 0	3 2 2	
P_2	3 0 2	9 0 2	
P_3	2 1 1	2 2 2	
P_4	0 0 2	4 3 3	

Use the Bankers' algorithm to determine whether the system is in a safe state. Show all your working. **[10 marks]**

Question 5

a) Consider a banking system that maintains an account balance with two functions: deposit(amount) and withdraw(amount). These two functions are passed the amount that is to be deposited or withdrawn from the bank account balance. Assume that a husband and wife share a bank account. Concurrently, the husband calls the withdraw () function and the wife calls deposit (). Describe how a race condition is possible and what might be done to prevent the race condition from occurring. [6 marks]

b) Describe any two conditions necessary for deadlock to occur. [4 marks]

c) Suppose a disk drive has 200 cylinders numbered 0 through 199. Given that the queue of pending requests (work queue) is in FIFO order as follows; 30, 90, 140, 50, and 190. The Read-write head(disk arm) is initially at track 100. With the aid diagrams, describe and calculate the total distance that the disk arm moves for each of the following disk scheduling algorithms;

    i) First Come First Service (FCFS)

    ii) Shortest Seek Time First (SSTF)

    iii) SCAN. [15 marks]