THE OPEN UNIVERSITY OF KENYA

DESIGN PLAN

Programme title	Bachelor of Science in Cybersecurity and Digital Forensics
Course title	Operating Systems
Learning Module number	05
Learning module title	Process Management
Module Developer	Elisha Abade
Module duration in hours	8
Instructional Hour Equivalent (Divide duration by 2)	4
Reviewed by	
Vision	The innovative university for inclusive prosperity
Audience description	Learners of Cyber Security in first semester of second year
Instructions to learners ⓘ	In this course we shall be learning about the basic concepts of an Operating System. We'll begin by watching videos on Operating systems. You are encouraged to ensure that you have reliable Internet access and that your devices (computer, tablet or phone) have properly working multimedia systems. This module also presents a number of interactive and non-interactive activities. You will be required to complete all the activities.
Learning module description	This module aims to facilitate learners to have an understanding of the concept of processes and how the Operating System creates and manages processes.
Module objectives:	This module aims at facilitating learners to acquire knowledge about: 1. Processes in operating systems; 2. Process scheduling algorithms; 3. Process synchronization
Module learning outcomes:	By the end of the module, you should be able to: 1. Define processes in operating systems; 2. Describe the mechanisms for process management 3. Sketch the process control block data structure for process management

	4. Analyze process scheduling algorithms
Planned Learning Resources	
ACTIVITY 1: INTRODUCTION VIDEO 1: Pre-recorded lecture on topic emphasizing LEARNING OUTCOME 1: Factual knowledge. 	**Video 1: Introduction to Processes (8 minutes)** Welcome to this fifth module of the Operating Systems course. In this module, we will learn about some detailed concepts on how an Operating System is designed and constructed. In order to achieve this, we shall be looking at the following areas: 1. The concept of a process in Operating Systems 2. Process lifecycle 3. Process management A process is the most central concept in Operating Systems. It represents an abstraction of a running program. A process is therefore commonly defined as a program in execution. It is the basic unit of protection and resource allocation. It has one or more threads inside it. A process exists in three distinct states, namely: **running, ready** and **blocked**. A newly created process moves to a ready state implying it is ready for execution but is waiting for its CPU time. When it gets the CPU time it changes to running state. It then moves to a blocked state when its time slot expires or when it requires some I/O operations. ***Provide a graphical illustration of the process states.*** ***New =>Ready=>Running=>Blocked*** ***Running=>Blocked=>Ready*** ***Running=Exit*** A process lifecycle therefore comprises three stages of process creation, blocking and termination. Process creation is when an Operating System makes a process to exist and happens due to any of the following events: 1. System initialization. 2. Execution of a process-creation system call by a running process. 3. A user request to create a new process. 4. Initiation of a batch job.

The process will then move to a ready state then runs as it performs some tasks. It can keep changing between running and blocked states as explained earlier. However, processes don't run forever. At some point in time they must terminate.

A process may terminate on the following conditions:

1. Normal exit (voluntary).
2. Error exit (voluntary).
3. Fatal error (involuntary).
4. Killed by another process (involuntary).

Process management

The Operating System maintains information about every process in a special data structure called Process Control Block (PCB). The information stored entails the process context which refers to the state of Program Counter register, general purpose registers, Caches, TLBs and Page tables.

Insert a diagram showing a Process Control Block. This will be a block diagram divided into components labeled as follows from top to bottom:

- ***Process number (or Process ID)***
- ***Current Process State***
- ***CPU scheduling information***
- ***Program Counter (PC)***
- ***Other CPU registers***
- ***Memory Management Information***
- ***Other Information (e.g. list of open files, name of executables, identity of owner, CPU time used so far, devices owned)***
- ***References to previous and next PCBs***

To switch between processes, an Operating System saves the context of the currently executing process and restores the context of the process being loaded. This is referred to as **context switching.**

Video 2: Process scheduling algorithms

Welcome to the second session of this module. In this session, we shall be looking at the scheduling algorithms. This will help us to understand how the Operating System implements scheduling of processes for execution.

There are a number of algorithms that have been proposed in process scheduling. These include:

1. First-Come First-Served
2. Shortest Job First
3. Shortest Response Time First
4. Predicting Burst Length
5. Round Robin
6. Priority scheduling

First-come First-served

This is the simplest possible scheduling algorithm. In this approach, the processes are executed depending only on the order in which they arrive. FCFS is simple but not terribly robust to different arrival processes.

Shortest Job First

Intuition from FCFS leads us to the shortest job first (SJF) scheduling algorithm. In this approach, each process is associated with the length of its next CPU burst. These lengths are used to schedule the process with the shortest time. In an event of a tie, FCFS will be used to break the tie. The SJF is optimal with respect to average waiting time since it minimises the average waiting time for a given set of processes.

Shortest Response Time First

This is a preemptive version of SJF. It provides that a processor will preempt the running process if a new process arrives with a CPU burst length that is less than the remaining time of the current executing process.

Predicting Burst Length

Both SJF and SRTF require the next "burst length" for each process. This means that a processor must have a way of estimating it. The processor does this by using the length of previous CPU bursts. The processor adopts the exponential averaging technique to achieve this.

Round Robin

This is a preemptive scheduling scheme for time-sharing systems. It works by defining a small fixed unit of time called a quantum (or time-slice). This is typically 10 to 100 milliseconds. In this approach, the process at the front of the ready queue is allocated the CPU for (up to) one quantum. When the time has elapsed, the process is preempted and appended to the ready queue.

	Some of the characteristics of round robin scheduling are: ● **It is a fair** algorithm. For n processes in the ready queue and a time quantum q, each process gets $1/n^{th}$ of the CPU. ● It is **always live.** For n processes and q quantum time, it guarantees that no process waits more than (n-1)q time units before receiving a CPU allocation. **Priority scheduling** In this approach, the processor associates an integer value (priority) with each process. The highest priority process has the smallest integer value. The processor therefore allocates CPU to the highest priority process, typically the one with the smallest integer. It therefore means that the some algorithms such as SJF can be considered variants of the priority algorithm where priority is the predicted next CPU burst time.
ACTIVITY 2: READING READING MATERIAL 1 	In this section, you have been provided with information on where to get resources for additional reading required in order to have a full grasp of the contents of this course. These include: 1) Andrew S Tanenbaum. (2016). Modern Operating Systems Paperback. Pearson. pp 85 - 165; https://www.amazon.com/Modern-Operating-Systems-Andrew-Tanenbaum/dp/9332575770#detailBullets_feature_div 2) Remzi H.,Andrea C. (2014). Operating Systems - Three Operating Systems. pp 25 - 33
ACTIVITY 3: Comprehension questions: 	1) Name and describe the different states that a process can exist in at any given time. 2) Explain the concept of a context switch 3) Describe why multi-core processing is more efficient than placing each processor on its own chip. 4) A computer system has enough room to hold five programs in its main memory. These programs are idle waiting for I/O half the time. What fraction of the CPU time is wasted?

<table>
<tr><td></td><td>5) Explain the main differences between a short-term and long-term scheduler.
6) Explain the difference between an I/O-bound process and a CPU-bound process.
7) What role does the dispatcher play in CPU scheduling?</td></tr>
<tr><td>LEARNING OUTCOME 2:
Conceptual knowledge

ACTIVITY 4: Video to be used.</td><td></td></tr>
<tr><td>CASE 1:
 
</td><td>Describe case here.

Consider a case in which a processor has 4 processes that need to be handled in the CPU, each with a corresponding burst time as indicated below:

<table><tr><td>Process</td><td>Burst Time (in nanosec)</td></tr><tr><td>P1</td><td>6</td></tr><tr><td>P2</td><td>8</td></tr><tr><td>P3</td><td>7</td></tr><tr><td>P4</td><td>3</td></tr></table>
Show how these processes can be scheduled using:
a) First come first served algorithm
b) Shortest Job First Algorithm</td></tr>
<tr><td>ACTIVITY 5: READING MATERIAL
  </td><td>The study tonight portal has several tutorials on process scheduling. Please read them from the following links:

1) Process scheduling

https://www.studytonight.com/operating-system/process-scheduling

2) CPU scheduling

https://www.studytonight.com/operating-system/cpu-scheduling

a) Having read the above articles, you are required to write a blog in the LMS with focus on summary of process scheduling algorithms.</td></tr>
</table>

ACTIVITY 6: ONLINE DISCUSSION 	Your course instructor will create a discussion forum in the LMS to facilitate online group discussions. You are required to read the discussion topic and give comments. You are also encouraged to comment on contributions from at least three members of your group. You can use the LMS platform to send questions to your instructor on the discussion topics that he/she has posted on the LMS. The group discussion will be graded based on a weight that will be indicated on the LMS.
LEARNING OUTCOME 3: PRACTICAL SKILLS VIDEO 3: 	Watch this 6-minute video in order to gain further understanding of the concept of process. The video will help you understand: 1. What a process is 2. The structure of a process 3. The concept of heap and stack as used in processes.
ACTIVITY 7: Learner practice sessions	In this session, you are required to do a "lightning talk" focusing on "*Process State and Process Control Block (PCB)*". In the "lightning talk", use your smartphone or any other video camera to record yourself in not more than "60 seconds" while explaining how "***a Process State and how PCB works***". 1. Upload your video with the captions <*fname_lname_talk5*>. Where "*fname*" is your first name and "*lname*" is your last name (or surname). The video must not be more than 60 seconds long.
ASSESSMENT OF PRACTICAL SKILL:	In the above activity, you uploaded your video, <***fname_lname_talk5***>. It will be assessed by the instructor by looking at among others: a) Accuracy of the assertions you have made (5 Marks) b) Degree of completeness of your response to the task (3 Marks) c) Adherence to the requirements with regards to topic and length of the video. (2 Marks)
LEARNING OUTCOME 4: KEY/TRANSFERABLE SKILLS	The study tonight portal has several tutorials on process scheduling. Please read them from the following links: 1) First-come-first-serve https://www.studytonight.com/operating-system/first-come-first-serve

	2) Shortest Job First https://www.studytonight.com/operating-system/shortest-job-first 3) Priority Scheduling https://www.studytonight.com/operating-system/priority-scheduling 4) Round Robin https://www.studytonight.com/operating-system/round-robin-scheduling 5) Multilevel Queue scheduling https://www.studytonight.com/operating-system/multilevel-queue-scheduling 6) Multilevel Feedback Queue scheduling https://www.studytonight.com/operating-system/multilevel-feedback-queue-scheduling 7) Comparison Algorithms https://www.studytonight.com/operating-system/comparision-scheduling-algorithms
ACTIVITY 8	In this module, you have learnt about processes in Operating Systems. You are required to write a two page essay on process management and scheduling algorithms clearly elucidating the strengths and weaknesses of each. Your instructor will create an activity in the LMS that will allow you to submit this essay for assessment. The essay will be marked out of 15 Marks. Some of the guidelines to success in this activity include: a) Originality (avoid copying from the Internet and other sources) (5 Marks) b) Level of accuracy of the essay content (5 Marks) c) Completeness of content (3 Marks) d) Sticking to length (number of pages) requirements (1 Mark) e) Keeping to the theme (1 Mark)

QUIZZ: 	1. Which of the following options defines a process in Operating Systems? a) A program in execution b) An instance of a program running on a computer. c) The entity that can be assigned to and executed d) All of the above. 2. Which of the following are the states of a five state process model? i) Running ii) Ready iii) New iv) Exit v) Destroy a) i, ii, iii and v only b) i, ii, iv and v only c) i, ii, iii, and iv only d) All i, ii, iii, iv and v 3. State which statement is true for Suspended process? i) The process is not immediately available for execution. ii) The process may be removed from suspended state automatically without removal order. a) i only b) ii only c) i and ii only d) None 4. Following is/are the reasons for process suspension. a) Swapping parent process b) Inter request c) Timing d) All of the above 5. Process Management function of an operating system kernel includes. a) Process creation and termination. b) Process scheduling and dispatching c) Process switching d) All of the above 6. The typical elements of process image are ..... i) User data ii) System Data iii) User program iv) System stack a) i, iii and iv only b) i, ii, and iv only c) ii, iii, and iv only d) All i, ii, iii, and i 7. Match the following mechanisms for interrupting the execution of a process and their uses. i) Interrupt a) Call to an operating system function ii) Trap b) Reaction to an asynchronous external event

	iii) Supervisor Call c) Handling of a error or an exception condition a) i-a, ii-b, iii-c b) i-c, ii-a, iii-b c) i-b, ii-c, iii-a d) i-a, ii-c, iii-b Answers: 1. a) All of the above. 2. c) i, ii, iii, and iv only 3. a) i only 4. d) All of the above 5. d) All of the above 6. a) i, iii and iv only 7. c) i-b, ii-c, iii-a
TAKE HOME MESSAGE	Your course instructor will create a feedback section in the LMS to facilitate provision of your take home message. You are required to give a brief description of what you have learnt in this module in not more than half a page (typed) in the feedback section provided.
Reference list	1. Andrew S Tanenbaum. (2016). *Modern Operating Systems Paperback, 5th Edition*. Pearson. 2. Silberschatz A., Galvin P. B. and Gagne G. (2008). *Operating System Concepts*, 8th Edition. Wiley. ISBN: 9780470128725 3. Meyers, M. (2016). *CompTIA A+ Certification Guide*. McGraw- Hill Education