National University of Sciences & Technology (NUST)
School of Electrical Engineering and Computer Science (SEECS)
Department of Computing

CS-330 Operating Systems

Course Code:	CS-330	**Semester:**	5th
Credit Hours:	3+1	**Prerequisite Codes:**	CS-110 Fundamentals of Computer Programming
Instructor:	Muhammad Ali Tahir	**Class:**	BESE-5 (AB)
Office:	IAEC Block A-103	**Telephone:**	-
Lecture Days:	Monday, Tuesday, Thursday	**E-mail:**	ali.tahir@seecs.edu.pk
Class Room:	CR-04,06,09,14	**Consulting Hours:**	Mon 10am-12pm or by appointment
Lab Engineer:	Rabbia Hassan (A) Nadeem Nawaz (B)	**Lab Engineer Email:**	rabbia.hassan@seecs.edu.pk nadeem.nawaz@seecs.edu.pk
Knowledge Group:	Operating Systems	**Updates on LMS:**	Once a week

Course Description:

The purpose of this course is to teach the design and implementation of operating systems. Topics covered include concepts of operating systems and systems programming; processes, threads, inter-process communication, and synchronization; memory allocation, segmentation, paging; loading and linking, libraries; resource allocation, scheduling, performance evaluation; I/O systems, storage devices, and file systems. The course will emphasize a highly hands-on approach asking students to implement thread scheduling, user programs, systems calls and virtual memory using the Pintos instructional operating system.

Course Objectives:

The main objective of the course is to teach students how to: 1) Design and implement systems-level software, 2) Understand how real operating systems work, and 3) Appreciate the tradeoffs involved in operating systems design.

Course Learning Outcomes (CLOs):

At the end of the course the students will be able to:	**BT Level***	**PLO**
1. Explain & summarize OS Services and Abstractions	C-2	PLO-1
2. Analyze the applicability of different OS Algorithms	C-4	PLO-2
3. Design & implement various pieces of OS software	C-5	PLO-3
4. Develop programs to interact with OS components through its API	C-5	PLO-5

* BT= Bloom's Taxonomy, C=Cognitive domain, P=Psychomotor domain, A= Affective domain

Program Learning Outcomes (PLOs):	
i	**Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
ii	**Problem Analysis:** An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
iii	**Design/Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
iv	**Investigation:** An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.
v	**Modern Tool Usage:** An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.
vi	**The Engineer and Society:** An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.
vii	**Environment and Sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
viii	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
ix	**Individual and Team Work:** An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.
x	**Communication:** An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
xi	**Project Management:** An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.
xii	**Lifelong Learning:** An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Books:	
Text Book:	1. William Stallings, Operating Systems: Internals and Design Principles, 8th Edition, Prentice Hall, January 2014 **2. Avi Silberschatz, Peter Baer Galvin, and Greg Gagne, Operating System Concepts, 9th Edition, John Wiley & Sons, Inc. ISBN 978-1-118-06333-0, December 2012.**
Reference Books:	1. Andrew S Tanenbaum, Modern Operating Systems, 4th Edition, Publisher: Prentice Hall, September 2014.

Week	Lecture Topic	Reading List
01	Introduction to OS and Linux	OSIDP (Ch#1, #2)
02	Processes	OSIDP (Ch#3)
03	Processes and Threads	OSIDP (Ch#4)
04	Thread Scheduling	Slide References
05	Threads Synchronization – I	OSIDP (Ch#5)
06	**OHT-1**	
07	Threads Synchronization – II	OSIDP (Ch#5)
08	POSIX Threads	OSIDP (Ch#3, Ch#4)
09	Memory Management: Main Memory	OSIDP (Ch#7, Ch#8)
10	Memory Management: Virtual Memory – I	OSIDP (Ch#7, Ch#8)
11	Memory Management: Virtual Memory – II	OSIDP (Ch#7, Ch#8)
12	**OHT-2**	
13	File Systems – I	OSIDP (Ch#11)
14	File Systems – II	OSIDP (Ch#11)
15	I/O	OSIDP (Ch#11)
16	Advanced Topic: Virtualization – I	MOS (Ch#8)
17	Advanced Topic: Virtualization – II	MOS (Ch#8)
18	**End Semester Exam**	

Lab Experiments	
01	Introduction to Linux
02	Observing OS Behavior
03	Pintos Programming Assignment 1
04	Inter-process Communication – I
05	Pintos Programming Assignment 2
06	System Calls
07	Synchronization - 1
08	Synchronization - 2

09	Pintos Programming Assignment 3
10	Memory Management – I
11	Memory Management – 2
12	Interacting with Linux Files

Tentative Grading Policy:

Theory

10% Quizzes
10% Assignments
30% OHT
10% Project
40% Final Exam

Practical

60% Weekly Labs
40% Semester Project

Tools / Software Requirement:

Linux OS (preferably Ubuntu 14.04+), GNU C Compiler (GCC), Virtualization Software (VirtualBox/VMWare Player)

Semester Project:

At the end of this course a semester project will be given to students. This project will be according to the PEC guidelines of a **Complex Engineering Problem**. Students will be able to mentally assimilate important concepts, as they will have to design and implement various key OS related functions in the scope of this project. The project will have enough open-endedness to allow for reasonable demonstration of students' problem-solving and designing skills.
Example: Design a real-time operating system (RTOS) for a military navigation based application.

Proposed Improvements:

As proposed by the instructor for previous years OS course, this time in the course we will:

1. Have more emphasis on PintOS assignments and exams due to its effectiveness in assessing students' concepts.
2. Give importance to increasing student motivation and making them realize the importance of this course, as abstract concepts of the course can cause the students to lose focus and motivation.
3. Make efforts to sanction a 24/7 availability of a Linux-based cluster.

Grading Policy:	
Quiz Policy:	The quizzes may be unannounced and normally last for ten minutes. The question framed is to test the concepts involved in last few lectures.
Assignment Policy:	The course website will be the primary source for announcements and submitting assignments.
Lab Conduct:	The labs will be conducted for three hours every week. A lab handout will be given in advance for study and analysis. The lab handouts will also be placed on LMS. The students are to submit their lab tasks at the end of lab for evaluation. One submission per group will be required. However, students may also be evaluated by oral viva during the lab.
Plagiarism:	Collaboration and group wok is encouraged but each student is required to submit his/her own contribution(s). Your writings must be your own thoughts. You must cite and acknowledge all sources of information in your assignments. Cheating and plagiarism will not be tolerated and will lead to strict penalties including zero marks in assignments as well as referral to the Dean for appropriate action(s).