Course Description Format

TITLE : Advanced Operating Systems
Course Code : XXXXXX
Note: Please use course code for previously existing course

CREDITS : 4
TYPE-WHEN : Monsoon
FACULTY NAME : TBD

PRE-REQUISITE :

1. **Undergraduate OS course, C programming proficiency**
2. **Access to a personal laptop or remote computer from the class room**

OBJECTIVE : Computer is a tool which consists of machine part and operating part. The operating part provides services to users and applications so that the underlying machine can be used in an efficient and convenient manner. The objective of this course is to understand the operating system (operating part) of a computer machine. In this course we study the general principles of operating system design by focusing on a general-purpose, multi-user, uni-processor systems.

This course will primarily study general purpose, time-shared operating systemsThe purpose of this course is to introduce some of the fundamental concepts in the design of a time-shared operating system. These include:

- Process Management, inter-process communication, synchronization, Concurrency
- CPU scheduling
- Memory management and virtual memory

The course would aim to be hands-on, relying on detailed experimentation to gain better understanding of fundamental principles of operating systems by exploring the Linux kernel. One of the goals of this course is to expose students to Linux OS (a.k.a. Linux Kernel) internals to provide an up-close view of its design and features. For some of the concepts, recent research works proposing extensions/optimizations will also be covered.

Course objectives:

1. Understanding the principles of design of operating systems
2. Look at four major OS Components in depth: System Call, Memory Management, CPU Scheduling and Concurrency
3. Understanding the design and functioning of Linux kernel components
4. Experiencing the kernel by passive/active observation
5. Extending the Linux kernel for deeper understanding
6. Exploring current research trends in OS, Linux being the reference OS

COURSE TOPICS :

History of Operating Systems, Processes and OS Abstractions, OS APIs, Interrupts and system calls, Introduction to the Linux Kernel, Compiling the kernel, Module programming, Writing your own system calls, Overview of kernel startup and initialization, Kernel Debugging Techniques, Interrupts - PICs, APICs, exceptions (traps) and hard interrupts, IDTs, Address Spaces and Loading, Virtual Memory, Memory allocators, Overview of memory spaces: logical segmentation, linear virtual, actual physical, Detecting BIOS-provided physical RAM map, paging, buddy system, setting up page directories (global, upper, middle), tables and PTEs, (N)UMA, nodes, zone, memory types, Setting up buddy system, Allocating contiguous pages from buddy system, Setting up slabs for small memory objects, CPU Scheduling, Threads, Process - structures, organization, initialization, Concurrent Programming, Locking, Deadlocks, Structures: thread union, thread info, stack, task, and thread struct, Creating kernel threads, using kthread, Kernel process scheduling, Scheduling processes with red-black tree, process switching, Context switches, Switching to suspended process, Linux File Systems and Disk Scheduling.

PREFERRED TEXT BOOKS:

1. Thomas Anderson and Michael Dahlin
   Operating Systems: Principles and Practice, 2nd Edition
   Recursive books (August 21, 2014),
   ISBN: 0985673524
2. Daniel P. Bovet & Marco Cesati
   Understanding the Linux Kernel (3rd edition)
   O'Reilly & Associates, November 2005.
   ISBN: 0596005652

***REFERENCE BOOKS:**

1. Remzi Arpaci-Dusseau and Andrea Arpaci-Dusseau
   Operating Systems: Three Easy Pieces
   Arpaci-Dusseau Books
   August, 2018 (Version 1.00)
2. Jonathan Corbet; Alessandro Rubini; Greg Kroah-Hartman
   Linux Device Drivers (3rd edition)
   O'Reilly & Associates, February 2005.
   ISBN-13: 978-0-596-00590-0
3. Robert Love
   Linux Kernel Development **(3nd Edition)**
   Addison-Wesley Professional, 2010.
   ISBN: 0672329468
4. Ellen Siever, Stephen Figgins, Robert Love, and Arnold Robbins
   Linux in a Nutshell, 6th Edition
   O'Reilly & Associates, September 2009.
   ISBN: 978-0-596-15448-6

***PROJECT:**
Project topics will be assigned during the first few weeks of the course constituting 50% of the course weightage.
GRADING PLAN:

Type of Evaluation	Weightage (in %)
Mid Sem-1 Exam	**12**
Mid Sem-2 Exam	**-**
End Sem Exam (Viva/Written)	**20**
Assignments	**18**
Project	**40**
Term Paper	**10**
Other Evaluation _____	

OUTCOME:
The student should come out with a renewed appreciation of OS concepts and a deeper, hands-on understanding of the components that form the fundamental blocks of Operating Systems. Along with this the student would develop a familiarity with the Linux kernel and the confidence to manipulate it, if required.
REMARKS: