CS3841 Operating Systems

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You may use 1 8.5 x 11 inch sheet of paper with notes and other supporting material for the exam.

1. Week #1
   (a) Lecture #1 Working in C
      i. Draw the C flow of C compilation from source code to object code.
      ii. Explain the purpose for the preprocessor, compiler, and linker within the C compilation model
      iii. Using the gcc compiler, generate the output for the preprocessor stage of compilation
      iv. Explain the concept of a dependency.
      v. Create a GNU Make file which automatically generates dependencies, creates preprocessed source code, and links a given C application.
   (b) Lecture #2 Introduction to Operating Systems
      i. Compare and Contrast the User View and System View of an operating system.
      ii. Explain the difference between user mode and kernel mode within an operating system.
      iii. Define the term Operating System
      iv. Draw a representation of a modern computer system.
      v. Draw the storage structure hierarchy for a computer system.
      vi. Explain the difference between a trap and an interrupt.
      vii. Explain, in the context of an operating system, multiprogramming.
      viii. Explain, in the context of an operating system, time sharing.
      ix. Understand and use the ls, man, cd, rm, cp, cat, more, less, tar, sort, kill, and ps commands.
   (c) Lecture #3 Operating Systems Structures
      i. List and characterize operating systems services (User interface, program execution, IO, file system manipulation, communications, error detection, resource allocation, accounting, protection and security)
      ii. Compare and contrast the command interpreter and graphical user interface approaches to interface with the computer.
      iii. Compare and contrast approaches to command interpreter implementation
      iv. List various UNIX shells
      v. Explain how a system call is made
      vi. Explain the concept of a system call
      vii. Explain the usage of the malloc and free operations within the C programming language.
      viii. Construct simple C programs which use malloc and free to solve problems.
      ix. Implement Screen and File I/O in C, showing how the system calls are invoked
2. Week #2
   (a) Lecture #1 Operating Systems Design and Virtual Machines
      i. Compare and contrast simple structured operating systems, layered operating systems, microkernels, and module based operating systems.
      ii. List the limitations of the MS-DOS operating system.
      iii. Draw a picture for a layered operating system.
      iv. List the advantages of a layered operating system.
      v. List the problems of designing a layered operating system.
      vi. Explain the fundamental purpose for the microkernel within a microkernel based operating system.
      vii. Explain the relationship between a layered architecture and a virtual machine.

viii. List the benefits of using a virtual machine.
ix. Define simulation in the context of virtual machines.
x. Explain the construction and operation of the Java Virtual Machine and .Net virtual machiens.

(b) Lecture #2 Processes

i. Explain the flow of control when an operating system boots
ii. Define the term process
iii. Draw a graphical representation of a process in memory
iv. Explain the concept of process state
v. Draw a state transition diagram for process states
vi. List the contents of a process control block
vii. Explain what the process scheduler is responsible for doing within the operating system.
viii. Explain the concept of process dispatching
ix. Obtain information about the executing processes under Windows and Linux

(c) Lecture #3 Process Operations

i. Explain how a CPU Context switch occurs
ii. Explain how the hardware may impact the time necessary for a context switch (i.e. Sun Ultra Sparc)
iii. List reasons why a context switch would occur
iv. Explain why context switching can be bad
v. Compare and contrast IO Bound and CPU Bound processes
vi. Explain the purpose for the UNIX fork, wait, and exec commands.
vii. Construct programs using the fork, wait, and exec unix commands
viii. Explain how a process is terminated.
ix. Execute a UNIX command in the background using the shell
x. Use the UNIX command shell to terminate a process

3. Week #3

(a) Lecture #1

i. Explain why it is important to allow processes to execute in parallel.
ii. List two methods for interprocess communication
iii. Explain the difference between indirect and direct communication in terms of message passing.
iv. Explain how UML sequence diagrams can be used to represent interprocess communications.
v. List the advantages and disadvantages of using shared memory for interprocess communication.
vi. List the advantages and disadvantages of using pipes for interprocess communication.
vii. Construct a rudimentary program using shared memory.
viii. Construct a rudimentary program using pipes.

(b) Lecture #2

i. Define a socket
ii. Explain the concept of loopback and recognize the ip address associated with loopback.
iii. Define the acronym RPC
iv. Explain how an RPC executes, specifically in regards to stubs and the concept of marshalling.
v. Explain the difference between “big-endian” and “little-endian”.

(c) Lecture #3

i. Explain the concept of a thread
ii. Draw a representation of a single threaded process and a multi-threaded process.
iii. Compare and Contrast the advantages and disadvantages of threads versus processes
iv. Explain how multi-threaded program can be useful in a multi-core environment.
v. Explain the difference between kernel threads and user threads
vi. Explain the difference between many to one, one to one, and many to many models of thread behavior
vii. List three commonly used thread libraries
viii. Explain the concept of the join call relative to a thread
ix. Implement multi-threaded software using Java and POSIX threads in C.

4. Week #4
   (a) Lecture #1
      i. Explain the interaction between threads and fork?
      ii. Explain the difference between asynchronous and deferred cancelation.
      iii. Explain the risks of improper termination of threads
      iv. Define the concept of a UNIX Signal.
      v. Explain the challenges of signal handling in a multi-threaded environment.
      vi. Explain the concept of thread pools
   (b) Lecture #2
      i. Explain the CPU and IO Burst cycle used for scheduling
      ii. Recognize the distribution of CPU activities on a system
      iii. Explain the relationship between an IO bound program and CPU bound program in terms of CPU bursts
      iv. List the five reasons why the scheduler may be invoked
      v. Compare and Contrast Pre-emptive and non-preemptive scheduling. What are the advantages of one system versus the other, and how is the operating system different based on the two approaches?
      vi. Explain the purpose for the dispatcher and scheduler within the operating system.
      vii. Define CPU utilization, Throughput, Turnaround time, Waiting time, Response time in terms of their impact on scheduling.
      viii. Explain the operation of a FIFO scheduler
      ix. Explain the convoy effect of FCFS Scheduling
   (c) Lecture #3
      i. Explain the algorithm for SJF Scheduling
      ii. Explain why exponential averaging can be used to estimate the shortest job burst.
      iii. Calculate the exponential average based on a series of CPU bursts and an initial estimate.
      iv. Explain priority scheduling.
      v. Using priority scheduling, draw a schedule for a set of jobs
      vi. Define starvation in terms of processor scheduling
      vii. Demonstrate how processor aging can solve the process of starvation
      viii. Explain round robin scheduling
      ix. Explain the relationship between quantum length and performance.
      x. For all scheduling algorithms
         A. Draw GANTT Chart showing processing sequence
         B. Calculate the average waiting time
      xi. Justify the design decisions for the Linux kernel based upon scheduling theory
      xii. Explain the concept of the UNIX nice command
5. Week #5
   (a) Lecture #1
      i. Midterm Exam

1 Lab Outcomes

1. Lab 1: Getting used to Linux
   (a) Demonstrate an ability to use a Linux shell.
   (b) Use the man command to obtain documentation about Linux commands.
   (c) Explain how to list the contents of a directory in multiple forms.
   (d) Navigate the Linux file system by changing directories.
   (e) Manage the creation and deletion of new files and directories from within the command shell.
   (f) Capture the output of a Linux program executing to a file.
   (g) Manage the creation and extraction of zip files and tarballs using the command shell.

(h) Construct a makefile which will automatically generate the project as well as allow for the clean building of source code.

2. Lab 2: Memory Management and Data Structures in C

   (a) Use malloc and free to manage the allocation and deallocation of dynamic memory.
   (b) Implement a doubly linked list in C.
   (c) Understand the purpose for the void pointer in C.
   (d) Apply appropriate casts to correctly use a void pointer.
   (e) Implement and use C struct to solve a software problem.
   (f) Use test cases to verify the correct operation of a constructed source code module.

3. Lab 3: Counting Words

   (a) Practice C development in a UNIX environment.
   (b) Construct software in C which uses File input and output routines.
   (c) Manage dynamic memory and heap allocation using C methods.
   (d) Use previously developed libraries as a part of a software development.
   (e) Practice the usage of UNIX piping to chain UNIX programs.