

## Approximate Lecture Schedule

This outline is *approximate*, as to coverage and timing.

### Lecture      Topics

- 1      introduction, processes, multiprogramming.
- 2      EIT, scheduler, CPU scheduling system model, CPU scheduling, goals.
- 3      CPU scheduling, metrics, constraints, open vs. closed systems, user characteristics, job characteristics, FIFO, round robin, little's formula, CPU Scheduling: SJF, SPT, SRPT, FB, MLFB, Exponential queue,
- 4      CPU scheduling: fair share scheduler, countermeasures. Discrete event simulation. Cooperating processes, atomic operations, critical sections, too much milk problem. Synchronization with semaphores.
- 5      Synchronization: producers and consumers, readers and writers, dining philosophers.
- 6      Threads. Synchronization with Condition Variables. Unix implementation. Monitors. Semaphore implementation, disabling interrupts.
- 7      Deadlock, deadlock prevention. deadlock avoidance, banker's algorithm, recovery, roll-back. Unix file locking.
- 8      Linkers and loaders. Dynamic storage allocation: stacks, heaps, fragmentation, (external/internal)first fit, best fit, next fit, bit map, reference counts, garbage collection, buddy system.
- 9      Memory management - flat memory, relocation (static, dynamic), base and bounds, swapping.
- 10     Multiple variable length segments, address translation, processes vs. threads, managing segments, paging (intro)
- 11     Paging: translation, PTBR, pros/cons, page tables, page table implementation, wired down pages, paging and segmentation combined, sharing, paging vs. segmentation.

- 12 Paging: copy on write, address space communication, I/O in paging system, sharing, 370 implementation, VAX implementation, TLB, principle of locality, translator.
- 13 Demand paging, principle of locality, page faults. paging fetch algorithms, page replacement algorithms (RAND, FIFO, LRU, MIN/OPT), real vs. virtual time.
- 14 Evaluation of paging algorithms, stack algorithms. implementing LRU, clock algorithm, local vs. global replacement.
- 15 Thrashing, working sets. page fault frequency, page size, I/O and paging, trace driven simulation, modifying code to minimize paging, algorithm comparison.
- 16 I/O device characteristics and device management.
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- 18 File and I/O systems - disk management, file allocation, contiguous allocation, linked files, multilevel indexed file, simple indexed file, dynamic optimized allocation (Demos), free block list.
- 19 I/O optimization: block size, disk arm sked (fcfs, sstf, scan, cscan), rotational scheduling, skip sector allocation, track offset for head switching, file placement, disk caching, prefetching, data replication, ALIS, RAID.
- 20 File descriptor, tree structured directories, links, symbolic links, root, tree structured directories, working directory, operations on files, file backup and recovery.
- 21 Networks and communications protocols, examples, hardware, topologies, performance parameters, protocols, ISO, wide area nets, broadcast nets, ethernet.
- 22 Networks: ring networks, circuit switching, packet switching, names vs. routes, communication problems, datagrams, TCP/IP, NFS.
- 23 Protection and security: problems, levels of info protection, design principles, authentication, authorization determination, access lists, capabilities, Multics protection, access enforcement, common problems.
- 24 Protection: examples of penetration, countermeasures, inference controls, confinement problem, viruses.
- 25 Encryption: substitution, transposition, codes, cryptanalysis, key distribution, DES, public key encryption, safe mail, digital signatures, Clipper Chip.
- 26 Virtual Machines, VMM, emulators, implementation, memory mapping, I/O, VM performance. Real Time Systems - deadlines.

- 27 Performance evaluation: measurement, hardware monitoring, software monitoring, multics, GTF, workload characterization, analytic modeling, queueing networks, simulation, back-of-the-envelope calculations. Hints for OS designers. Current research in Operating Systems.