

ECE 753: Fault-Tolerant Computing

(Spring 2023)

TENTATIVE COURSE OUTLINE

1. Introduction to ECE 753 (1 lecture)
 - importance of fault-tolerant computing
 - overview of the course
2. Terminology (2 lectures)
 - fault and error
 - reliability, availability, dependability, . . .
 - error detection, location, recovery and reconfiguration
 - overview of hardware and software fault-tolerance schemes
3. Fault modeling (2 lectures)
 - transistor level fault models
 - logic level fault models
 - higher level fault models
 - permanent, intermittent and transient faults
 - Recent data HPC systems, Blue Waters
4. Simple concepts in fault-tolerance (2 lectures)
 - hardware, time, information, software redundancy
 - simplex, duplex, tmr, nmr systems
 - sparing and notion of coverage
 - recovery block, n-version
5. Review of probability and intro to markov chains (1 lecture)
 - random variable and stochastic processes
 - PDF, expected values, conditional probability
 - example distributions
 - transition matrix, recurrent, transient, . . .
 - Transient and steady-state analysis
6. Reliability/availability of commonly used configurations (3 lectures)
 - simplex, duplex, tmr, nmr
 - impact of coverage on reliability
 - impact of performance and notion of performability
7. Low level fault-tolerance techniques (4 lectures)
 - error detection and correction fundamentals
 - parity, linear block, cyclic, arithmetic codes

- self-checking and fail-safe circuits
 - concurrent error detection and watchdog processors [mahm:88], [schu:87]
8. Higher level fault-tolerance techniques (4 lectures)
- Crash, timing and Byzantine fault models
 - Interactive consistency
 - Clock synchronization
9. Software fault-tolerance (2 lectures)
- checkpointing, recovery block
 - N-version programming
 - modeling of software reliability [rama:82]
10. Case studies (3 lectures)
- Machine learning
 - Autonomous driving
 - Industrial applications
 - Quantum computing
11. Wrap-up and project presentations (2 lectures) 5/2, 5/4, 5/9 2:45-4:45p Final exam slot)