Problem 1 (20 Points)
Read the attached paper and answer the following using concise statements.
a. Three fundamental terms used in this course are fault, error, and failure. In one to three sentences, clearly distinguish these terms from each other.
b. What is the difference between a permanent fault, an intermittent fault, and a transient fault in term of fault duration?
c. Comment on the following statement with justification. Single faults can cause multiple bit errors and multiple faults can cause single error.
d. Comment on the following statement with justification. A fault-tolerant system necessarily has a high reliability.
e. Define the following: reliability, availability, safety, and performability. Does a system with a high availability necessarily have a high reliability?

Problem 2 (10 Points)
Design a one-bit 5MR voter using basic gates.

Problem 3 (20 Points)
A cyclic code is to be based on the Generator polynomial $X^8 + X^6 + X^5 + X^2 + 1$.
a. Generate a codeword for the input data 10111.
b. Using logic gates, design an appropriate encoder and decoder the given generator.

Problem 4 (20 Points)
A 2M X 16 memory system is design using 1 M X 4 chips. Assume chip failure modes are single-bit cell (45%), single-row all-0's (30%), single-column all-0's (15%), and whole-chip all-0's (10%). Also, assume 0 and 1 values are equally likely. Compare and comment on relative performance (single-error-detection coverage) and overhead of the following approaches.
a. Bit per chip
b. Bit per multiple chips
c. Duplication
d. Single precision checksum (one sum for the entire memory).

Problem 5 (10 Points)
a. Draw a block diagram showing the overall structure of a reconfigurable NMR system (i.e. N-modular redundancy with spares) based on hybrid redundancy. Briefly explain how the system tolerates fault.
b. Compare and contrast hybrid redundancy with active redundancy scheme. Discuss the main advantages and disadvantages of the two methods.

Due September 20, 2004