

## Problem 1 (20 Points)

Read the attached paper and answer the following using concise statements.

- Three fundamental terms used in this course are *fault*, *error*, and, *failure*. In one to three sentences, clearly distinguish these terms from each other.
- What is the difference between a *permanent fault*, an *intermittent fault*, and a *transient fault* in term of fault duration?
- Comment on the following statement with justification. Single faults can cause multiple bit errors and multiple faults can cause single error.
- Comment on the following statement with justification. A fault-tolerant system necessarily has a high reliability.
- 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  $X^8 + X^6 + X^5 + X^2 + 1$ .

- Generate a codeword for the input data 10111.
- 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.

- Bit per chip
- Bit per multiple chips
- Duplication
- Single precision checksum (one sum for the entire memory).

## Problem 5 (10 Points)

- 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.
- Compare and contrast hybrid redundancy with active redundancy scheme. Discuss the main advantages and disadvantages of the two methods.

Due September 20, 2004