

READ CAREFULLY BEFORE BEGINNING

1. This exam comprises 25% (400 level) or 20% (500 level) of your total grade. Points are indicated for each question/section.
2. This is an **closed book, closed notes** exam.
3. On-campus: You have **50** minutes to finish.
4. Video: You have **55** minutes to finish.
5. Make sure your copy has **6** questions.
6. Read each question completely before answering. Be sure you understand all assumptions and constraints. **Show all work and state all assumptions.** Partial credit can not be given for work not shown. Use the back of the page, if necessary.

REG MAXIMUM	100
DEDUCTIONS	—
TOTAL SCORE	

PRINTED NAME _____

1. (15 pts) We want to use Hamming codes:

(a) Define the Hamming Distance (HD) of two code words:

(b) Define the Hamming distance of a code:

(c) Below are words that should be used to construct a 4-word code with Hamming distance 3. Which words should be selected? Verify that your HD is 3.

$$w_1 = 000000$$

$$w_2 = 000111$$

$$w_3 = 111000$$

$$w_4 = 101010$$

$$w_5 = 010101$$

$$w_6 = 111111$$

(d) Give the example of a received word that is not in your code, but can be corrected.

2. (10 pts) This question relates to cyclic codes utilizing the generator $G(X) = X^3 + X + 1$.

(a) For the following two messages calculate the Frame Check Sequence. $M_1 = 000011$, and $M_2 = 100$.

(b) Draw the shift register circuit.

(c) Does CRC address error *detection* or error *correction*?

(d) If the degree of $G(x)$ is n and all error patterns are equally likely, what is the probability that a long burst error is not detected?

3. (20 pts) Answer the following questions:

(a) Define *Fault*

(b) Define *Error*

(c) Define *Failure*

(d) Define the term *Reliability* $R(t)$.

(e) What is a *series-parallel graph*?

(f) What is the definition of an *Irreducible Markov Chain*

4. (20 pts) A flight control system consists of three processors, two inertia units and three actuator control units. The minimal configuration of the system is: one processor, one inertia unit and one actuator control unit.

(a) Draw the Reliability Block Diagram for this system.

(b) Draw the Fault Tree for this system.

(c) Draw a partial Markov chain represents this system. Starting with the initial state representing a fully loaded system, considering one transition out of the initial state. Use a meaningful state notation! Do **not** go further than one transition away from the initial state! The fail rates for processors, inertia and actuator control units are λ_{PE} , λ_{INU} and λ_{ACU} respectively. respectively.

5. (20 pts) This question deals with Petri Nets:

(a) A Petri Net is defined by a 5-tuple $\{P, T, A, W, M_0\}$. Define

P :

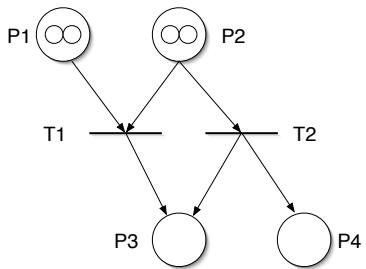
T :

A :

W :

M_0 :

(b) Given the following Petri Net, show the reachability graph.



(c) Draw the Petri net for a 3-of-5 system with fail rate λ .

6. (15 pts) Assume we have a TMR (2-of-3 system) that contains identical modules with fail rate λ failures per hour. Assume the modules obey the exponential failure law.

(a) Derive the expression for $R(t)$.

(b) Derive and calculate the MTTF, assuming $\lambda = 10^{-4}$.

Extra Workspace