

### READ CAREFULLY BEFORE BEGINNING

1. This exam comprises 25% for 400 level, 20% for 500 level of your total grade. Points are indicated for each question/section.
2. This is an **open book/notes** exam.
3. This is an 1 hour exam but you have 2 hour to finish.
4. Make sure your copy has **5** questions.
5. Read each question completely before answering. Be sure you understand all assumptions and constraints.
6. **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 \_\_\_\_\_

SIGNATURE \_\_\_\_\_

1. (15) Assume there are 8 processors with sensor values  $v_1, \dots, v_8$  of 12, 5.4, 5, 6, 5.2, 6.6, 11, and 7 respectively.

(a) Someone suggest a consensus approach based on the Byzantine Agreement algorithm by Lamport. Is this algorithm suitable for this scenario? Justify your answer.

(b) Assuming that  $k = 2$  and  $\delta = 3$ , what is the voted value of processor  $P_5$  after applying approximate agreement using:

i. Egocentric Average - where each processor replaces all values outside of the valid range with its own value).

ii. Fast Convergence:

iii. Fault-tolerant Midpoint:

iv. Fault-tolerant Average:

2. (25) With respect to the Boeing 777 flight control (paper by Bob Yeh):

(a) Draw a Petri-Net for the PFC configuration. Make sure your triple-TMR system fails at the correct number of processors.

(b) Now assume we had a dual-4MR, where each 4MR is a 2-of-4 system. Derive the Markov chain for such system.

(c) How many PFCs, ACEs and how many inertia units are there?

i. PFC:

ii. ACE:

iii. inertia units:



4. (20) With respect to diagnosability:

(a) Assume there is a system consisting of  $N$  processing units and you are using the PMC model forming a ring. In general, if  $N$  is large, can this system be one-step 2-fault-diagnosable? Justify your answer.

(b) A system consists of processing units numbered  $U_0, \dots, U_7$  configured as a ring. The connection assignment for the PMC diagnosability model is that each unit tests its successor in the ring. Given that  $U_2$  and  $U_4$  are faulty, show how these two faults are diagnosed by using syndromes. Show your steps.

(c) In the Adaptive Distributed System Diagnostics of Bianchini and Buskens, what would be the values of the TESTED\_UP<sub>1</sub> array? Assume that  $U_2$  and  $U_4$  are faulty.



