King Mongkut's University of Technology Thonburi
Midterm Examination of the First Semester, Academic Year 2014

COURSE CPE 354 Optimization Design & Evolutionary Computing **Computer Engineering Department**
Thursday 25 September 2014 **13.00-16.00h.**

Instructions

1. This examination contains 7 main problems, 7 pages (including this cover page).
2. The answers must be written in these examination sheets.
3. Students are allowed to use calculators.
4. One sheet of A4 is allowed in the examination room (นำกระดาษ A4 เข้าได้ 1 แผ่น, 2 ด้าน)
5. No book and notes are allowed in the examination room.

Students must raise their hands to inform to the proctor upon their completion of the examination, to ask for permission to leave the examination room.
Students must not take the examination and the answers out of the examination room.

Students will be punished if they violate any examination rules. The highest punishment is dismissal.

This examination is designed by

Assoc.Prof. Dr. Naruemon Wattanapongsakorn

Tel. 0-2470-9089

This midterm examination is approved by the computer engineering department.

Student Name _____ Student ID _____ Seat No._____

Problem	Score	Obtained Score
1	4 x 3 = 12	
2	8	
3	9	
4	10	
5	10	
6	8	
7	8 + 5 = 13	
Total	**70**	

1. Many optimization techniques are considered for the following problems 1.1-1.4. (12 points)
    a) Linear Programming
    b) Integer Programming
    c) Dynamic Programming
    d) Genetic Algorithm
    e) Random Search
    f) Gradient Search (Hill-climbing)
    g) Iterated Search
    h) Simulated Annealing

1.1. Which technique(s) should be used to solve a small non-linear optimization problem?

1.2. Which technique(s) should be used for a very complex non-linear optimization problem? Why?

1.3. Which techniques are not guaranteed for the optimal solution? Why?

1.4. Which techniques consist of both exploration and exploitation techniques? Explain the parts that use exploration and/or exploitation.

2. Mathematical (Linear) Programming. (10 points)

Find the optimal solution for the following problem by plotting a corresponding graph with linear functions.

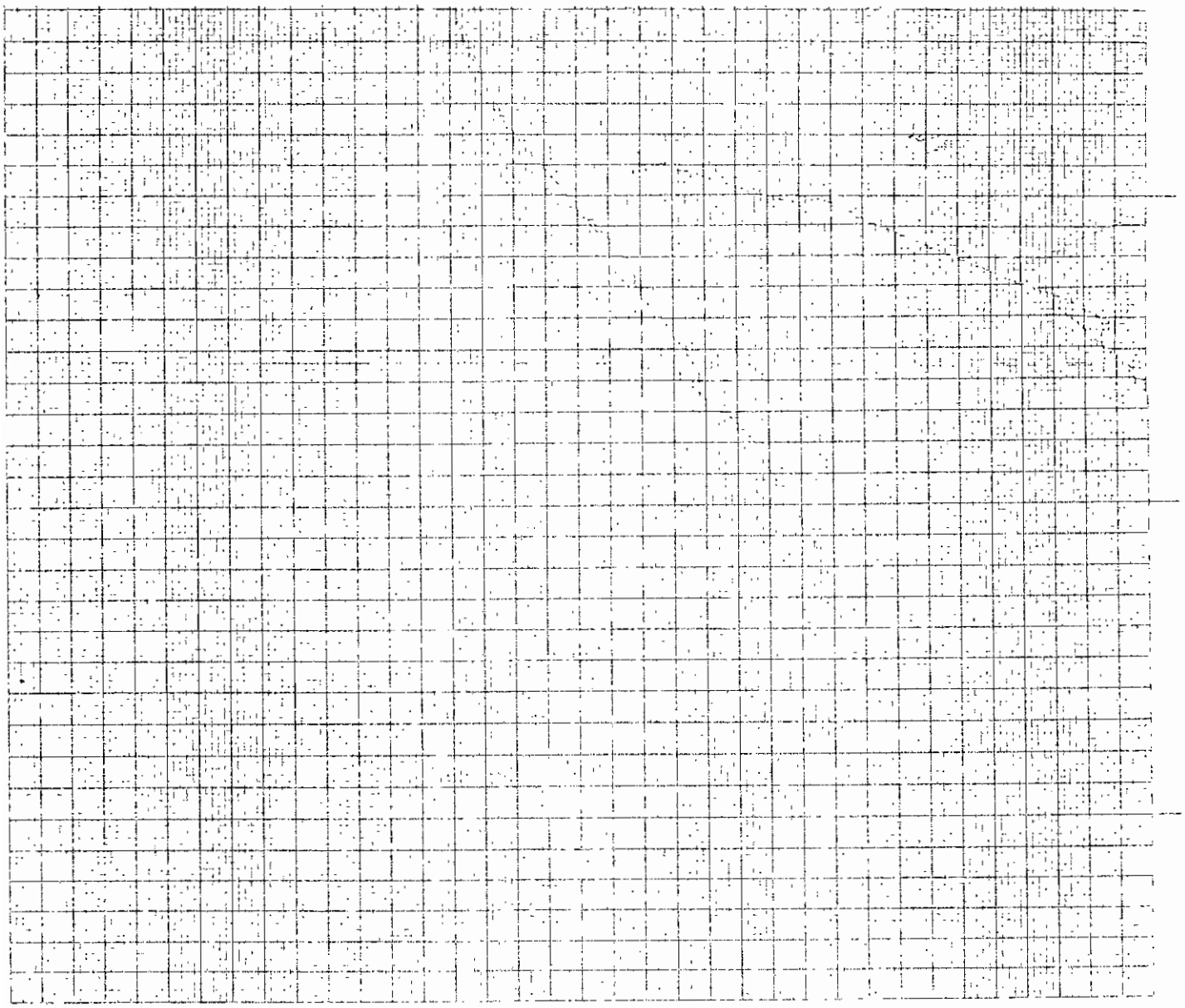
Max $Z = 3x_1 + 2x_2$

Subject to $x_1 \leq 4$

$x_1 + 3x_2 \leq 15$

$2x_1 + x_2 \leq 10$

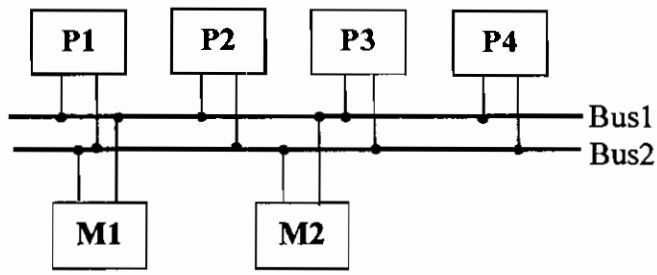
and $x_1 \geq 0, x_2 \geq 0$



3. Describe the software fault-tolerant architectures: Recovery Block (RB) and N-Version Programming. Compare them in terms of computation time, reliability and cost. Which architecture is the best? Explain all in detail. (9 points)

Fault-Tolerant archetecture	**Computation Time (worst case)**	**Reliability**	**Cost**
Recovery Block (RB): RB/1/1			
N-Version Programming: NVP/0/1			
N-Version Programming: NVP/1/1			

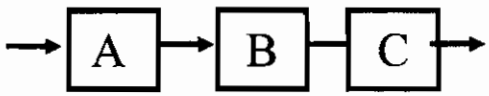
4. Consider a 4P2M system with 4 processors, 2 memory units, and 2 buses connected as shown in the figure. For correct operation, the system needs only 2 processors, 1 memory unit, and 1 bus. **Find the system reliability.** Show your work step by step. (10 points)



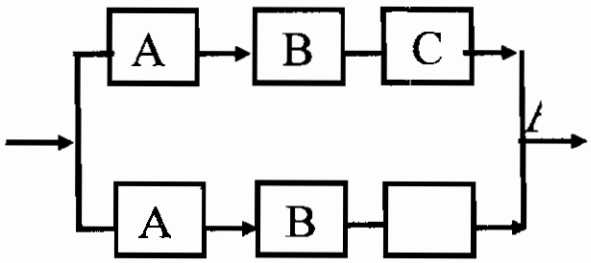
4P2M System

Given that each processor has reliability 0.97, each memory has reliability 0.95, and each bus has reliability 0.99.

5. A system consists of three major components, A, B, C with reliability 0.8, 0.9 and 0.85, respectively. Find the corresponding system reliability and identify the system if it has high-level redundancy or low-level redundancy. **When** should we apply component redundancy into a system design? Discuss the **advantage/ disadvantage** of each redundancy type. (10 points)



This system reliability is _____



Redundancy type is _____

This system reliability is _____

Draw the updated system with the remaining type of redundancy (high-level or low-level redundancy). The system consists of 2 sets of A, B, and C components.

Redundancy type is _____

This system reliability is _____

6. Define the following terms (8 points)

6.1 k-out-of-n redundancy. What is the value of k that gives the highest reliability?

6.2 Tournament Selection

6.3 Dynamic programming

6.4 Exploitation vs. Exploration

7. Consider a component allocation problem for a system design. The system consists of 5 subsystems connected in series. Each subsystem consists of software and hardware of 3 architecture choices i.e., without redundancy or with redundancy of type NVP/0/1 or RB/1/1. There are 4 hardware component types and 4 software types/versions available for each subsystem. Each component has its own reliability and cost as shown below. (13 points)

Assumption R_{ij} = reliability of hardware type j available at subsystem i

R_{ik} = reliability of software type k available at subsystem i

C_{ij} = cost of hardware type j available at subsystem i

C_{ik} = cost of hardware type k available at subsystem i

The objective of this system design is to maximize system reliability considering system cost constraint.

7.1 Formulate this system reliability optimization model. Define all the variables and notations. (8 points)

7.2 How many different solutions are there for this system design? Show your analysis.
(5 points)