國　立　清　華　大　學　命　題　紙

95 學年度工業工程與工程管理學系（所）甲組 碩士班入學考試

科目 作業研究 科目代碼 2002 共 5 頁第 1 頁

注意事項: (1) 依題號順序作答。
(2) 答案必須寫在**答案卷**上,計算過程與推導可寫在答案卷上,但答案須依每一題規定的方式作答。
(3) 未依規定作答,酌量扣分

10%

1. 以下選擇題(單選題)每一小題 2 分, 共 10 分, 必須在**答案卷**畫出以下表格並在表格內填寫答案。

題目	(1-1)	(1-2)	(1-3)	(1-4)	(1-5)
答案					

(1-1) Why is there waiting in an infinite source queueing system?
(A) poor scheduling (B) slow service (C) low utilization (D) variability in arrival and service rates (E) multiple phase processing

(1-2) A basic difference between infinite source and finite source queueing models is:
(A) the number of servers (B) the average waiting time (C) the arrival distribution (D) size of potential calling population (E) processing rate

(1-3) If a manager increases system utilization (assuming no change in the customer arrival rate) what happens to the customer waiting time?
(A) it increases exponentially (B) it increases proportionally (C) it decreases proportionally (D) it decreases exponentially (E) no change

(1-4) A single phase queueing system is one which has a single:
(A) channel (B) server (C) customer being served (D) operation (E) waiting line

(1-5) Which of the following is not generally considered as a measure of system performance in a queueing analysis?
(A) the average number waiting in line (B) the average number in the system (C) system utilization (D) the cost of servers plus customer waiting cost (E) service time

15%

2. 以下選擇題(單選題)每一小題 3 分, 共 15 分, 必須在答案卷畫出以下表格並在表格內填寫答案。

題目	(2-1)	(2-2)	(2-3)	(2-4)	(2-5)
答案					

(2-1) Which of the following will equal the average time a customer is in the system?

1 : average number in the system divided by the arrival rate

2 : average number in the system multiplied by the arrival rate

3 : average time in line plus average service time

(A) 1 only (B) 2 only (C) 1 and 3 (D) 2 and 3 (E) 3 only

(2-2) A multiple channel queueing system with a Poisson arrival rate and exponential service time has an average rate of 4 customers per hour and an average service time of 18 minutes per customer. The minimum number of servers required to avoid an overloaded system is:

(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

(2-3) Which one of the following measures of system performance is a key measure in the manufacturing system?

(A) average number of customers waiting in line (B) average time customers wait in line (C) average time customers are in the system (D) average number of customers in the system (E) probability that an arrival will have to wait for service

(2-4) A single channel queueing system has an average time of 16 minutes per customer, which is exponentially distributed. The manager is thinking of converting to a system with a constant service time of 16 minutes. The arrival rate will remain the same. The effect will be to:

(A) increase utilization (B) decrease utilization (C) increase the average waiting time (D) decrease the average waiting time (E) not have any effect since the service time is unchanged

(2-5) Which of the following is not an assumption of an infinite source, multiple priorities M/M/1 queueing model?

(A) Poisson arrival rates (B) Poisson service rates (C) customers are processed in order of arrival (D) customers wait in a single line (E) all of the above are assumptions

25%

3. The reservation office for Central Airlines has two agents answering incoming phone calls for flight reservations. In addition, one caller can be put on hold until one of the agents is available to take the call. If all three phone lines (both agent lines and he hold line) are busy, a potential customer gets a busy signal, in which case the call may go to another airlines. The calls and attempted calls occur randomly (i.e., according to a Poisson process) at a mean rate of 15 per hour. The length of a telephone conversation has an exponential distribution with a mean of 4 minutes.

(a) Describe the basic structure and its parameters of this queueing model. (5 分)

(b) Construct the rate diagram for this queueing system. (5 分)

(c) Develop the balance equations. (5 分)

(d) Find the steady-state probability that a caller will get to talk to an agent immediately. (5 分)

(e) Find the steady-state probability that a caller will get a busy signal. (5 分)

20%

4. True (T) or False (F)? 以下是非題每一小題2分, 但答錯一小題倒扣2分, 最多只扣到本題0分, 必須在答案卷畫出以下表格並在表格內填寫答案。

題目	(4-1)	(4-2)	(4-3)	(4-4)	(4-5)	(4-6)	(4-7)	(4-8)	(4-9)	(4-10)
答案										

(4-1) In an LP model, replace ≤ or ≥ by = in the constraints can improve the value of the objective function.

(4-2) In a linear program, the optimal solution must be an extreme point.

(4-3) An artificial variable column can be dropped all together from the simplex tableau once the variable becomes nonbasic.

(4-4) If the solution space is unbounded, the objective value always will be unbounded.

(4-5) If the slack variable of a constraint is positive, the unit worth of the corresponding resource may not equal to zero.

(4-6) The entire simplex tableau of a linear program can be computed from knowledge of the associated inverse matrix and the original model.

(4-7) If the primal problem has unbounded optimal, the dual problem is always infeasible

(4-8) Maximal flow problem can be solve by interior-point algorithm.

(4-9) For a linear program, starting with a given basis, the entering and leaving variables may not be the same in the tableau and revised simplex methods. (Both methods use the default rule.)

(4-10) If a linear program has two distinct optimal solutions, it has infinite number of optimal solutions.

12%

5. 以下計算題每一小題4分, 計算過程與推導必須寫在答案卷上,計算後必須在答案卷畫出以下表格並在表格內填寫答案。

題目	(5-1)	(5-2)	(5-3)
答案			

Consider the following LP and its optimal tableau.

$$\begin{aligned} \textit{maximize} \quad & z = c_1 x_1 + c_2 x_2 \\ \textit{subject to} \quad & a_{11}x_1 + a_{12}x_2 \le b_1 \\ & a_{21}x_1 + a_{22}x_2 \le b_2 \\ & x_i \ge 0, \quad i = 1, 2. \end{aligned}$$

z	x_1	x_2	x_3	x_4	Right Side
1	0	0	1/3	4/3	80
0	1	0	−1/3	2/3	20
0	0	1	2/3	−1/3	10

Let x_3 and x_4 be the slack variables of constraints 1 and 2 respectively. Determine

$(c_1, c_2) =$ (5-1) , $(b_1, b_2) =$ (5-2) , and $\begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} =$ (5-3) .

18%

6. 以下計算題每一小題 3 分, 計算過程與推導必須寫在答案卷上,計算後必須在**答案卷**畫出以下表格並在表格內填寫答案。

題目	(6-1)	(6-2)	(6-3)	(6-4)	(6-5)	(6-6)
答案						

Consider the following parametric linear programming problem.

$$\begin{aligned} \textit{maximize} \quad & z = (10 - 3\theta)x_1 + (4 + \theta)x_2 + (7 + \theta)x_3 \\ \textit{subject to} \quad & 3x_1 + x_2 + 2x_3 \le 7 \quad \text{(resource 1)}, \\ & 2x_1 + x_2 + 3x_3 \le 5 \quad \text{(resource 2)}, \\ & x_j \ge 0, \quad j = 1, 2, 3. \end{aligned}$$

where θ can be assigned any positive or negative values. Let x_4 and x_5 be the slack variables for the respective constraints. After we apply the simplex method with $\theta = 0$, the final simplex tableau is

z	x_1	x_2	x_3	x_4	x_5	Right Side
1	0	0	3	2	2	24
0	1	0	−1	1	−1	2
0	0	1	5	−2	3	1

A. Determine $[\alpha_1, \alpha_2]$ such that over the range $\alpha_1 \le \theta \le \alpha_2$ the above basic feasible solution will remain optimal. Find the objective value $f(\theta)$ (as a function of θ), and then find the best choice θ^* of θ within this range.

$[\alpha_1, \alpha_2] =$ (6-1), $f(\theta) =$ (6-2), $\theta^* =$ (6-3).

B. Given that θ within the range of values found in part A, identify the shadow prices $S_1(\theta)$, and $S_2(\theta)$ (as a function of θ) for the two resources.

$S_1(\theta) =$ (6-4), $S_2(\theta) =$ (6-5).

C. Use the information in B to determine the optimal value of the objective function $F(\theta)$ (as a function of θ) if the available amount of resource 1 were decreased by 1 and the available amount of resource 2 simultaneously were increased by 2.

$F(\theta) =$ (6-6).

—— The End ——