Faculty of Engineering

Prince of Songkla University

Midterm Examination : Semester 1 — Academic Year 2008 (2551)

Date : July 30, 2008 ( 30 กรกฎาคม 2551 ) — Time : 09:00 - 12:00

Subject : 225-348 Operations Research — Room : A301, A303

ทุจริตในการสอบ โทษขั้นต่ำ ปรับตกในวิชาที่ทุจริตนั้น
และพักการเรียน 1 ภาคการศึกษา

Instruction:

1. Total 5 topics, 23 pages, and 52 scores.
2. Do your examination in these papers and return all of them.
3. Write down your Name, Surname, and Student Code in every page.
4. Show all calculation and assumption.
5. All books, notes and calculators are allowed but you are not permitted to borrow anything from the others.
6. All figures are not to scale.
7. Draw the graph in plain paper and the scale should be approximately close to the fact.

| | Score | Your Scores |
|---|---|---|
| 1 | 9 | |
| 2 | 14 | |
| 3 | 9 | |
| 4 | 10 | |
| 5 | 10 | |
| Total | 52 | |

No.....

(From the number in examination list)

Name.....

Surname.....

Student Code.....

Year.....

Department.....

Assistant Professor Yodduang PANNARA

Name.....Surname.....Student Code.....

1). Describe or calculate all the problem with clear statement

1.1. What is Little's Formula ? Explain it as much as you can ( 1 score )

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1.2. Calculate the stripped area in figure 1.1. Explain how you calculate it ( 1 score )

Figure 1.1

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1.3. Calculate or estimate mean of poisson distribution from the data in figure 1.2 ( 1 score )

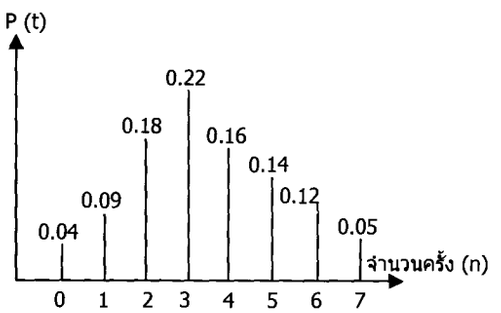


Figure 1.2 (Figure 1.2 is not to scale)

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Name.....Surname.....Student Code.....

1.4. Figure 1.3 is the data of customers come and leave the system. (Total 1.5 scores)

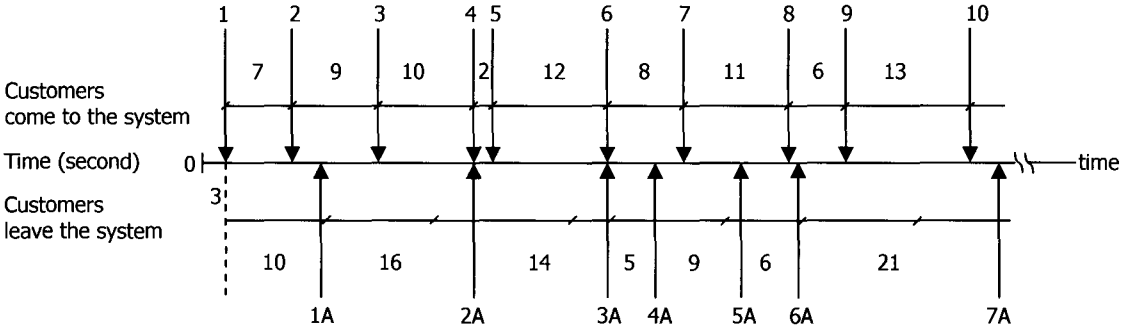


Figure 1.3

From the data in Figure 1.3, Analysis only the data that appear in figure 1.3 and /or show all calculation

1.4.1. Calculate mean inter arrival time. ( 0.5 score )

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1.4.2. Calculate mean service rate. ( 0.5 score )

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1.4.3. Calculate mean arrival rate. ( 0.5 score )

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Name.....Surname.....Student Code.....

1.5. From the topic of transient period and steady state period, from Figure 1.4a, 1.4b and 1.4c specify the transient period and steady state period and explain the reason. ( Total 1.5 scores )

1.5a ( 0.5 score )

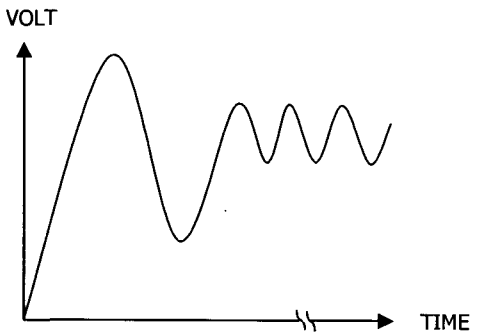


Figure 1.4a

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1.5b ( 0.5 score )

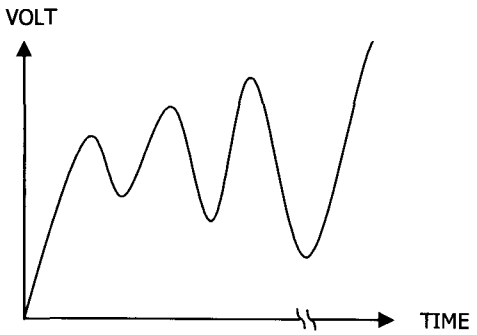


Figure 1.4b

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1.5c ( 0.5 score )

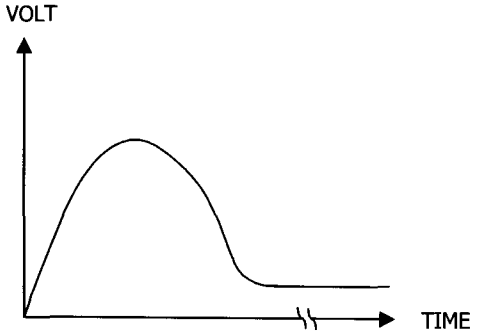


Figure 1.4c

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Name.....Surname.....Student Code.....

1.6. Describe the meaning of transient period and steady state Period. What are the different between both of them? ( 1 score )

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1.7. What is the purpose of each method to collect the data? If you have to collect the inventory data, what technique do you select? ( 1 scores )

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1.8. What is the meaning of " Boundaries of Model " ? ( 1 scores )

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( Total 9 scores )

Name.....Surname.....Student Code.....

2) The waiting cost for VTEC's storeroom are paid $20 per hour. They arrive at the mean rate of 13 minutes per customer and the distribution is exponential. The VTEC production manager is concerned about the manufacturing time lost by the employees at the parts storeroom. VTEC is considering two options for improving service.

First alternative is to replace the existing clerk with the specially trained and certified parts processor. Under this plan, the service rate which the distribution is exponential will increase from 6 to 10.5 customers per hour. However, the parts processor will be paid $10.5 per hour as compared to the $5.5 hourly wage of the existing clerk. Other fixed expenses for the storeroom facility would increase from $13,500 to $27,000 per year.

The other alternative, VTEC will add automatic to the current system. Purchase and Installation of the required equipment will add $10,000 to annual fixed expenses but provide a service rate of 13 customers per hour. The Service distribution is constant. The other fixed expenses for the storeroom facility are $28,000 per year. The service expense is $11 per hour.

VTEC's storeroom operates 10 hours per day, 300 days per year. VTEC's management must decide which option to select.

( 14 scores )

Name.....Surname.....Student Code.....

3). The service time is in figure 3.1. The customers arrive to system according to constant distribution with mean of 15 minutes per customer. Please calculate and/or draw the graph for the problems below.

3.1. If the maximum number of customers in the system is unlimited, when dose the transient period start and finish ? ( 1 score )

3.2. If the maximum number of customers in the system is unlimited, when does the second balk happen ? ( 1 score )

3.3. If the maximum number of customers in the system is 100, when dose the first balk happen ? ( 2 scores )

3.4. If the maximum number of customers in the system is 3, when dose the steady state period happen ? ( 1 score )

3.5. Suppose there are 4 customers in the system when the system start ( time = 0). If the maximum number of customers in the system is 7, when dose the first bulk happen ? ( 1 score )

3.6. Suppose there are 2 customers in the system when the system start ( time = 0). If the maximum number of customers in the system is 5, when dose the steady state period happen ? ( 1 score )

3.7. If the maximum number of customers in the system is 10, show the graph :

3.7.1. Customers come and leave the system within 0 to 200 minutes. ( 1 score )

3.7.2. Show the number of customers in the system within 0 to 200 minutes. ( 1 score )

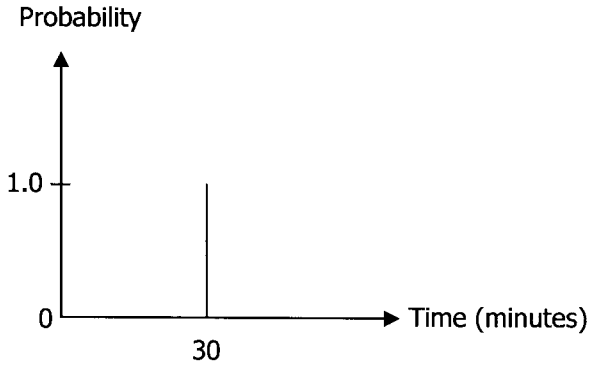


Figure 3.1

Remark: Draw the graph in plain paper and the scale should be approximately close to the fact.

( 9 scores )

Name.....Surname.....Student Code.....

4. Queuing System from figure 4.1, the probability of No. customer in the system ( $P_0$ ) is in table 4.1.

4.1. Explain the meaning of table 4.1 clearly ( 2 scores )

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4.2. The customers go to the system with mean 21 customers per hour with poisson distribution. The service time distribution with 6 servers is exponential distribution with mean 0.09 customer per minute per server. ( 8 scores )

At steady state period, find

4.2.1. The probability of finding 4 customers in the system.

4.2.2. The probability of finding 8 customers in the system.

4.2.3. Average number of customers in queue.

4.2.4. Average number of customers in the system.

4.2.5. Average time of customers in queue.

4.2.6. Average time of customers in the system.

**( Remark : Use the data from table 4.1 to help you to calculate this problem )**

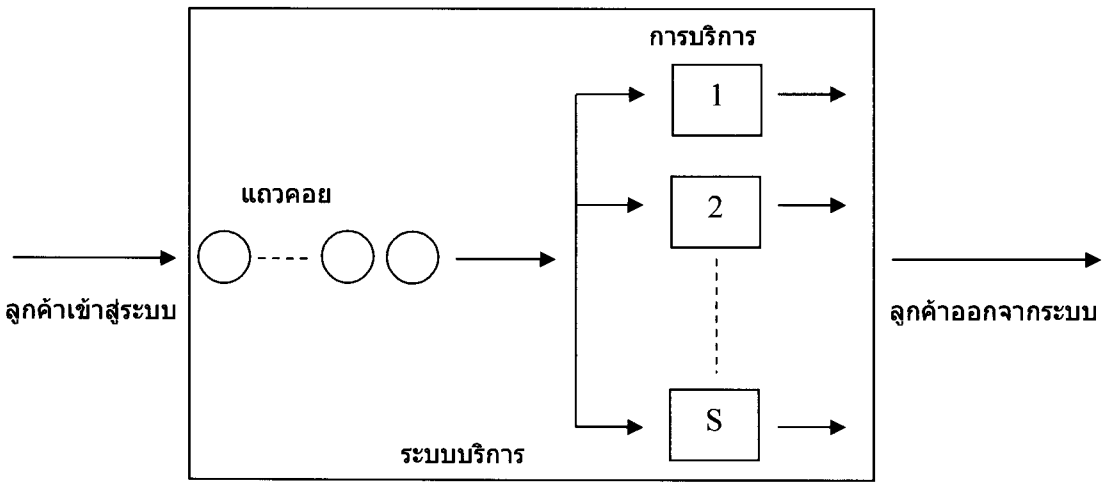


Figure 4.1

( Total 10 scores )

Probability of No. Customer in the System ( $P_0$ )

For Multiple-Server Facilities

| System utilization ratio $\rho = \lambda / s\mu$ | Number of servers (s) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| .05 | .9048 | .8607 | .8187 | .7788 | .7408 | .7047 | .6703 | .6376 | .6065 |
| .10 | .8182 | .7407 | .6703 | .6065 | .5488 | .4966 | .4493 | .4066 | .3679 |
| .15 | .7391 | .6373 | .5487 | .4724 | .4066 | .3499 | .3012 | .2592 | .2231 |
| .20 | .6667 | .5479 | .4491 | .3678 | .3012 | .2466 | .2019 | .1653 | .1353 |
| .25 | .6000 | .4706 | .3673 | .2863 | .2231 | .1738 | .1353 | .1054 | .0821 |
| .30 | .5385 | .4035 | .3002 | .2228 | .1652 | .1224 | .0907 | .0672 | .0498 |
| .35 | .4815 | .3451 | .2449 | .1731 | .1222 | .0862 | .0608 | .0428 | .0302 |
| .40 | .4286 | .2941 | .1993 | .1343 | .0903 | .0606 | .0407 | .0273 | .0183 |
| .45 | .3793 | .2496 | .1616 | .1039 | .0666 | .0426 | .0272 | .0174 | .0111 |
| .50 | .3333 | .2105 | .1304 | .0801 | .0490 | .0298 | .0182 | .0110 | .0067 |
| .55 | .2903 | .1762 | .1046 | .0614 | .0358 | .0208 | .0121 | .0070 | .0040 |
| .60 | .2500 | .1460 | .0831 | .0466 | .0260 | .0144 | .0080 | .0044 | .0024 |
| .65 | .2121 | .1193 | .0651 | .0350 | .0187 | .0099 | .0052 | .0028 | .0015 |
| .70 | .1765 | .0957 | .0502 | .0259 | .0132 | .0067 | .0034 | .0017 | .0009 |
| .75 | .1429 | .0748 | .0377 | .0187 | .0091 | .0044 | .0021 | .0010 | .0005 |
| .80 | .1111 | .0562 | .0273 | .0130 | .0061 | .0028 | .0013 | .0006 | .0003 |
| .85 | .0811 | .0396 | .0186 | .0085 | .0038 | .0017 | .0008 | .0003 | .0001 |
| .90 | .0526 | .0249 | .0113 | .0050 | .0021 | .0009 | .0004 | .0002 | .0001 |
| .95 | .0256 | .0118 | .0051 | .0022 | .0009 | .0004 | .0002 | .0001 | .0000 |

$\lambda$ = arrival rate ( Poisson )

s = number of servers

$\mu$ = service rate ( per individual server and exponential service time )

Table 4.1

Name.....Surname.....Student Code.....

5. Each day, the sales price of NGV tanks is 60,000 Baht/set, while its cost is 40,000 Baht per set. The fixed expense is 10,000 Baht/day. The variable expense is 2000N Baht/set. N is the amount of NGV tanks sold out per day. If N is $\geq$ 10, the variable expense is changed to 4000N Baht/set. If N $\geq$ 13, the variable expense is changed to $1400N^2$ Baht/set. However the shop must have the total profit from selling NGV tanks except it cannot sell any NGV tank in that day.

   From all the system above, draw the graph or calculate ( You select one method.)

   5.1. Profit from selling NGV tanks and the amount of NGV tanks sell for each day. ( 3 scores )

   5.2. The total net profit and the amount of NGV tanks sell each day. ( 3 scores )

   5.3. How many NGV tanks do we have to sell to make maximum total net profit ? ( 2 scores )

   5.4. If we can sell can unlimited amount of NGV tanks, how much is the maximum total net profit and what is the amount of NGV tank sale per day ? ( 2 scores )

Remarks : Draw the graph in plain paper and the scale should be approximately close to fact.

( Total 10 scores )