COB 291 Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exam IV Section \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Spring 2000 Dr. Scott Stevens

## SAMPLE FINAL EXAM: NON-CUMULATIVE

The following exam consists of 25 questions, whose point values are indicated below. You may, if you wish, use a 3” x 5” notecard as an aid on this exam.

 Work carefully; be sure to answer the question posed. If any question seems unclear or ambiguous to you, raise your hand, and I will try to clarify it.

 Maintain 4 significant digit accuracy!

Pledge:

On my honor as a JMU student, I have read and understand the directions above.

I pledge that I have neither given nor received unauthorized help on this

examination.

 Signature\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

DO NOT TURN THIS PAGE UNTIL YOU ARE INSTRUCTED TO DO SO!!!

|  |  |
| --- | --- |
| Questions | Point value  |
| 1-6 (Simulation) | 5 points each (30 total) |
| 7-9 (Queuing) | 3.5 points each (10.5 total) |
| 10-19 (Forecasting) | 1 point each (10 total) |
| 20-26 (Queuing) | 3.5 points each (24.5 total) |
| Total | 75 points |

The scenario for questions 1-9 appears below.

Florence Gerhardt works alone at the Customer Service Desk at a large shopping mall. During the Christmas season, the only activity that Florence has to worry about is wrapping the packages which shoppers bring to the desk. Shoppers can have Florence wrap up to four packages for them. Shoppers arrive at the desk in a Poisson fashion with a mean arrival rate of one customer every six minutes. Florence takes them in first come, first served order. Her average time to handle **all** of a customer’s packages is 4 minutes. Florence is using a new automatic package wrapping machine that wraps any package in exactly 2 minutes, so an individual’s service time depends only on how many packages a shopper brings. The details appear below.

We’re going to simulate Florence’s work for four customers. Below I’ve provided a table showing the relative frequency that a customer brings 1, 2, 3, or 4 packages to Florence. Additionally, I’ve provided an (approximate) table of for the interarrival times between successive customers, assuming Poisson arrivals. Below these, I’ve provided some room for you to conduct your simulation. Anything you write on this examination is for your own use; I’ll be grading only your scantron. As usual, begin your simulation with the simulation clock starting at time 0. The first shopper will arrive sometime after time 0. Assume that Flo has no customers at the beginning of the simulation.Our goal throughout this scenario is to determine the long term (steady state) behavior of this system.

Table A **(Generator A)** Table B **(Generator B)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| # of packages | relative frequency |  | # of minutes between successive arrivals(or # of minutes before first arrival) | probability |
| 1 | .4 |  | 0.5 | 0.16 |
| 2 | .3 |  | 1.5 | 0.12 |
| 3 | .2 |  | 3 | 0.22 |
| 4 | .1 |  | 5 | 0.13 |
| 8 | 0.20 |
| 16.5 | 0.17 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Shopper # | RN | # of minutes before this shopper arrives | Time shopper arrives | RN | # of packages | Time Florence begins wrapping | Time Florence completes wrapping |
| 1 | 0.757 | 8 | 8 | 0.221 | 1 | 8 | 10 |
| 2 | 0.058 | 0.5 | 8.5 | 0.184 | 1 | 10 | 12 |
| 3 | 0.132 | 0.5 | 9 | 0.562 | 2 | 12 | 16 |
| 4 | 0.938 | 16.5 | 25.5 | 0.653 | 2 | 25.5 | 29.5 |

To see the numbers that belong in the table above, highlight the entire table, then choose FONT COLOR AUTOMATIC from the FONT menu under the FORMAT menu, above.

1. How many minutes into the simulation does the first shopper arrive?

a) 0.5 minutes b) 1.5 minutes c) 3 minutes d) 5 minutes e) 8 minutes

1. How many minutes does it take Flo to wrap the packages of the third shopper?

a) 1 minute b) 2 minutes c) 3 minutes d) 4 minutes e) 5 minutes

1. How many minutes does the third shopper have to wait for his or her wrapping to begin?

a) 0 minutes b) 2 minutes c) 3 minutes d) 4 minutes e) 12 minute

1. Assume that the scenario description of the Customer Service desk is accurate. Then there are several reasons why a queuing analysis of this problem should be more reliable than our simulation analysis. Which of the following is not such a reason?
2. We did not have a process generator for the # of minutes required to wrap a customer’s packages.
3. We performed only a single simulation run.
4. We did not conduct the simulation for sufficient time to reach a steady state.
5. Our process generator for interarrival times only approximates the Poisson process.
6. Simulation results always include an element of statistical uncertainty.
7. Why is simulation such a widely used OR technique, relative to most other OR techniques?
8. It takes relatively little time to create and conduct a simulation analysis.
9. It costs relatively little money to create and conduct a simulation analysis.
10. It is a tool that can be applied to many complicated and mathematically intractable problems.
11. Even very sophisticated simulations can be done relatively easily in Excel.
12. Even when another technique is appropriate, simulation is usually more accurate.
13. For this question only, suppose that the wrapping machine breaks, so that Flo must wrap packages by hand. When she does so, there is a 40% chance any given package will take exactly 2 minutes to wrap, and a 60% chance that it will take 4 minutes to wrap. We could easily create a process generator for this "# of minutes to wrap a package". Call it **Generator C**. Recall Generators A and B from the previous page. Now suppose we wish to simulate this new situation, adding new columns to our old simulation, if needed, to account for the new variation in wrapping times. Then the maximum number of random numbers which would ever be needed to fill in any row of this table is

a) 3 b) 4 c) 5 d) 6 e)7

# Suppose we approach this scenario as a queuing model, rather than a simulation. Four of the assumptions below would be be acceptable for this model as described, but one would not. Which of the following assumptions would be most inappropriate?

1. single channel
2. single server
3. FCFS
4. exponential distribution of service times
5. infinite calling population
6. Suppose we approached this scenario as a queuing model, rather than a simulation. Then L­q­ would represent
7. the average number of customers coming to the Courtesy Desk per hour.
8. the average number of minutes a customer waits in line before Flo begins on his or her wrapping.
9. the average number of customers waiting in line for their wrapping to begin.
10. the average number of customers who leave the queue without being served (per hour).
11. the average number of customers who leave the queue (after being served) per hour.
12. Suppose we approached this scenario as a queuing model, rather than a simulation. If we measure time in minutes in the problem, then μ would equal

a) 1/6 b) ¼ c) ½ d) 2 e) 4

# END OF GIFT WRAPPING SCENARIO

# Question 10-19 refer to the scenario and information appearing on the last page of this examination. Look at that information carefully, then answer the questions below.

# Instructions for questions 10-14: For each graph listed in the left hand column, choose the forecasting technique in the right hand column which is most appropriate for it. For example, if you felt that Graph I was best approached using simple moving average, you would choose A for question 10. THE SAME TECHNIQUE MAY APPLY TO MORE THAN ONE GRAPH; HOWEVER, THE ANSWER E SHOULD BE USED AT MOST ONCE.

#  Graph I A. simple moving average

#  Graph II B. weighted moving average

#  Graph III C. linear regression

#  Graph IV D. seasonal-trend forecasting (section 16.4)

14. Graph V E. No technique above is appropriate

#  Compute the MAD of the forecast given in column F.

a) 5% b) 12% c) 16.83% d) 19% e) 166.4%

1. Suppose, regardless of its appropriateness, that we decided to apply linear regression to the data in Graph IV. Let x be the number of customers appearing during a shift, and let y be the total number of minutes spent with customers during that shift. Which of the following equations most closely approximates the regression line?
2. y = 9x + 5
3. y = 0.5x + 200
4. y = 0.1x2 –2.4x +16.4
5. y = 200 – 10x
6. y = x + 50

# It would not be appropriate to apply linear regression as a forecasting technique to the data in Graph I. This is because

1. the data forms a time series.
2. two data points have the same y value.
3. the data shows a consistent trend.
4. the data shows strong seasonal variation.
5. we have more observations for shift 1 and shift 2 than we do for shift 3.
6. Suppose we decide to use a weighted moving average to conduct a forecast of the data in Graph I. The value of n most appropriate to use would be

a) 1 b) 2 c) 3 d) 4 e) 5

1. Conduct a weighted moving average forecast of the data in Column E. Use n = 5 and let the weights (listed in order from most recent to earliest in time) be 6, 1, 1, 1, and 1. Then the forecast for the 3rd shift on Friday about

a) 27 b) 29.5 c) 31.5 d) 34 e) 300

# END OF RETURN DESK SCENARIO

**Questions 20-26 deal with the traffic cop scenario described below.**

A police officer is manning a speed trap on route 81, intending to ticket those drivers who are travelling at least 75 miles per hour. (The arrival pattern of such offenders follows a Poisson distribution.) If the officer is not already occupied with ticketing a speeder when such an offender reaches the trap, she will ticket the offender. The time required for the ticketing process is exponentially distributed.

Equations applicable to this problem appear below.

P0 = 1 - (λ/μ) Wq = Lq

 1 - (λ/μ)2 [1 - P1]λ

P1 = P0(λ/μ) Lq = L + P0 - 1 L = P1 W = Wq + (1/μ)

**For questions 20 and 21 ONLY, add these three additional sentences to the scenario:** Offenders arrive at the speed trap at a mean rate of one every 8 minutes. The mean time required for the ticketing process (of one speeder) is 10 minutes. In this problem, all times will be measured in **MINUTES**.

1. The value of λ for this problem should be

a) 0.1 b) 0.125 c) 1 d) 8 e) 10

1. The value of k for this problem should be

a) 0.1 b) 0.125 c) 1 d) 8 e) 10

For the rest of this scenario (questions 22-26) we make these assumptions:

* the correct value of λ for this problem is 4.5 speeders/hour.
* the correct value for mu is 5 speeders/hour.
1. The fraction of the time that the officer will be busy writing tickets is represented by the expression

a) P0 b) P1 c) P0 + P1 d) W e) Wq

1. In this problem, the value of P0 is

a) 0.0526 b) 0.1 c) 0.526 d) 1 e) 10

1. The value of Pw in this problem can be computed without having a formula for it. Its value is
	1. 0, because speeders are only stopped when the officer is free to ticket them
	2. 12 minutes, because the officer can handle 5 speeders per hour.
	3. 1, because every speeder who is stopped has to wait for a ticket.
	4. the same value as P1, because if the cop is writing a ticket, then the person she is ticketing has to wait.
	5. 0.9, because 90% of all speeders are caught.

25. What fraction of speeders pass the speed trap without receiving a ticket? (Hint: think about under what circumstances a speeder does not receive a ticket.) The answer is given by the expression

a) P0 b) P1 c) P0 + P1 d) W e) Wq

# END OF EXAMINATION

# The following information is used for questions 10-19.

We look at the Customer Service Desk at one of the department stores in the mall. This desk is open 12 hours a day, Monday through Friday, and the time each day is broken up into three 4-hour shifts, called simply the 1st shift, 2nd shift, and 3rd shift. We’ve collected data on the operation of this desk during the week after Christmas. You’ll find it below. On the other side of this page, you’ll see five graphs providing a visual representation of some of the table’s data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **A** | **B** | **C** | **D** | **E** | **F** |
| Shift | # of customers | mean # of minutes/customer | total # of minutes with customers (this shift) | % of transactionswhich are exchanges | Simple Moving Average on Column E, (n = 9) |
| Mon, 1st shift  | 15 | 11.3 | 169.3 | 32 |  |
| Mon, 2nd shift | 25 | 11.4 | 283.9 | 37 |  |
| Mon, 3rd shift | 12 | 11.0 | 131.7 | 45 |   |
| Tue, 1st shift  | 16 | 10.7 | 171.6 | 49 |  |
| Tue, 2nd shift | 25 | 10.3 | 257.1 | 52 |  |
| Tue, 3rd shift | 13 | 9.7 | 125.7 | 52 |   |
| Wed, 1st shift  | 13 | 9.7 | 126.7 | 51 |  |
| Wed, 2nd shift | 23 | 9.4 | 216.1 | 50 |  |
| Wed, 3rd shift | 12 | 8.8 | 105.7 | 46 |   |
| Thu, 1st shift  | 13 | 8.3 | 108.0 | 41 | 46 |
| Thu, 2nd shift | 24 | 8.2 | 196.1 | 37 | 47 |
| Thu, 3rd shift | 13 | 8.0 | 103.5 | 36 | 47 |
| Fri, 1st shift  | 15 | 7.9 | 118.9 | 31 | 46 |
| Fri, 2nd shift | 26 | 7.3 | 189.7 | 25 | 44 |
| Fri, 3rd shift |   |   |   |   | 41 |

As an example, during the first 4 hour shift on Monday, the desk served 15 customers, spending an average of 11.3 minutes per customer, resulting in a total of 169.3 minutes of contact time with customers. 32% of the transactions on this shift were exchanges of merchandise. All values are rounded to 1 decimal place.