**EASTERN MEDITERRANEAN UNIVERSITY**



**Department of Industrial Engineering**

**IENG314 and MANE314 Operations Research II**

**HOMEWORK 4 Spring 2021-22**

1. Suppose I arrive at an *M*/*E4*/6/FCFS/180/∞ queuing system when all servers are busy. What is the probability that I will complete service before at least one of the three customers in service?
2. The time between arrivals of buses follows an exponential distribution, with a mean of 15 minutes.
3. What is the probability that exactly five buses will arrive during the next 3 hours?
4. That at least two buses will arrive during the next one and half an hours?
5. That no buses will arrive during the next 2 hours? A bus has just arrived.
6. What is the probability that it will be between 40 and 75 minutes before the next bus arrives?
7. An average of 12 jobs per hour arrive at our departmental printer.
8. Use two different computations (one involving the Poisson and another exponential random variable) to determine the probability that no job will arrive during the next 15 minutes.
9. What is the probability that 3 or fewer jobs will arrive during the next 25 minutes?
10. My home uses two light bulbs. On average, a light bulb lasts for 22 days (exponentially distributed). When a light bulb burns out, it takes an average of 2 days (exponentially distributed) before I replace the bulb.
11. Formulate a three-state birth–death model of this situation.
12. Determine the fraction of the time that both light bulbs are working.
13. Determine the fraction of the time that no light bulbs are working.
14. Registration at State University proceeds as follows: Upon entering the registration hall, the students ﬁrst wait in line to register for classes. A single clerk handles registration for classes, and it takes the clerk an average of 2 minutes to handle a student’s registration. Next, the student must wait in line to pay fees. A single clerk handles the payment of fees. The clerk takes an average of 2 minutes to process a student’s fees. Then the student leaves the registration building. An average of 8 students per hour arrive at the registration hall.
    1. If interarrival and service times are exponential, what is the expected time a student spends in the registration hall?
    2. What is the probability that during the next 5 minutes, exactly 3 students will enter the registration hall?
    3. Without any further information, what is the probability that during the next 4 minutes, no student will arrive at the fee clerk’s desk?
15. Find the value and the optimal strategies for the two person zero-sum game in the following table

|  |  |  |  |
| --- | --- | --- | --- |
| 4 | 5 | 5 | 8 |
| 6 | 7 | 6 | 9 |
| 5 | 7 | 5 | 4 |
| 6 | 6 | 5 | 5 |

1. A fast-food restaurant has one drive-through window. An average of 40 customers per hour arrive at the window. It takes an average of 1 minute to serve a customer. Assume that inter-arrival and service times are exponential.
2. On the average, how many customers are waiting in line?
3. On the average, how long does a customer spend at the restaurant (from time of arrival to time service is completed)?
4. What fraction of the time are more than 3 cars waiting for service (this includes the car (if any) at the window)?
5. In a barber the rate for the number of the customers is 3 per hours. On an average the barber can serve customers at rate of one every 15 minutes.

A) Find average number of the customers in the barber (system) and queue?

B) Find average waiting time in the barber and queue?

C) What is the probability that the barber be empty?

D) What is the probability that exactly 2 customers present in the system?

1. A fair coin is tossed, and the result is shown to player 1. Player 1 must then decide whether to pass or bet. If player 1 passes, then he must pay player 2 $3. If player 1 bets, then player 2 (who does not know the result of the coin toss) may either fold or call the bet. If player 2 folds, then she pays player 1 $3. If player 2 calls and the coin comes up heads, then she pays player 1 $5; if player 2 calls and the coin comes up tails, then player 1 must pay her $5. Formulate this as a two-person zero-sum game. Then graphically determine the value of the game and each player’s optimal strategy.
2. Contemporary Issues Report must be 8-10 pages which contains (3 bonus points)
   1. Cover Page
   2. Table of Content
   3. Introduction (definition of contemporary issues and selected subjects)
   4. Contemporary Issues List (at least 5 new subjects)
   5. Selected Subject Explain with a Conclusion (at least four **hand writing** pages)
   6. References