Sample Midterm Questions (Set 2)

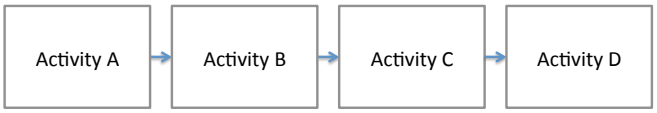
1. (3 points) The following questions are based on the article *Deep Change*. Indicate whether the following statement is true or false, and explain your answer. A "true" or "false" answer without sufficient explanation will not receive a full mark.

   (a) (1 point) The "secret" of Progressive Insurance between 1991-2002 was aggressive advertising campaigning coupled with *operational innovation*.

   (b) (1 point) In *cross-docking*, goods trucked to a distribution center from suppliers are immediately transferred to trucks bound for stores without being placed into storage. It was one of the ingredients for Wal-Mart's success.

   (c) (1 point) In 1980's, Taco Bell transformed its restaurant operations by thinking about them in manufacturing rather than in fast-food terms. The restaurant chain increased the amount of on-site food preparation instead of outsourcing it to its suppliers.

2. (8 points) Consider the following flow diagram for processing a customer order.



   The exact processing times and the resources needed for each activity are listed in the table below.

Activity	Time (minutes)	Resources Used
A	5	Alpha, Beta
B	10	Beta
C	15	Gamma
D	2	Alpha

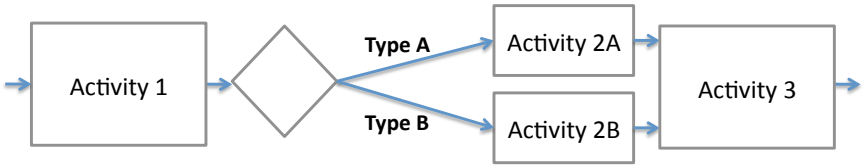
   For each of the resources listed above, the manager owns one unit of the resource.

   (a) (3 points) What is the capacity rate of this system?

   (b) (1 point) Assuming that the customer orders arrive every 15 minutes, what is the implied utilization of Resource Alpha?

   (c) (4 points) Suppose that the customer demand is so high that the sales volume is constrained by the capacity system (i.e., the system is running at its full capacity). Suppose that the sales price is fixed \$40 per order, 25% of which is attributed to marginal profit per customer order. What is the amount of profit earned per hour? Suppose that each of Alpha, Beta and Gamma can be leased at the at the cost of \$20, \$10 and \$15 per hour of operation per resource, respectively. If only one unit of the resource in total can be leased, which resource should be added?

3. (7 points) Consider the following flow diagram for processing a customer order, where each order is either Type A or Type B.



The exact processing times and the resources needed for each activity are listed in the table below.

Activity	Time (minutes)	Resources Used
1	10	Category I
2A	10	Category I
2B	30	Category II
3	10	Category I

There is one unit of Resource Category I in the system, and there are two units of Resource Category II in the system. Customers currently arrive at the rate of 2.5 per hour; one-fifth of the customers are Type A, and four-fifths of the customers are Type B. Product A generates a marginal profit of \$100 per unit; product B generates a marginal profit of \$110 per unit.

(a) (2 points) What is the bottleneck resource?

(b) (2 points) What are the implied utilization for each resource listed above?

(c) (1 point) What is the average profit per hour?

(d) (2 points) Suppose that a marketing campaign can increase *either* the demand rate of Type A by 10% or increase the demand rate of Type B by 10% (i.e., Type A demand can increase from the current 0.50 per hour to 0.55 per hour, *or* Type B demand can increase from 2 to 2.2). However, it requires the marketing cost of \$35 per hour. What should the manager decide? Explain.

4. (5 points) Suppose that a store opens at 8AM. Customers show up at the rate of 30 per hour until 1PM, and then at the rate of 45 per hour until 3PM. The store closes at 3:00PM regardless of the number of customers waiting in line, and the unsatisfied customers are sent away. Suppose that every customer who shows up at the store joins the line and waits until satisfied or sent away. The store can serve customers at the rate of 50 per hour between 8AM and 9AM, at the rate of 10 per hour between 9AM and 12 noon, and then at the rate of 40 per hour between 12 noon and 3PM.

   Use the continuous-time model in your calculation.

   (a) (2 points) How many customers do you expect to see in the line at 11:30AM? How many customers are sent away at the end of the day?

   (b) (3 points) Calculate the average number of waiting customers between 8AM and 3PM, and compute the average amount of time a customer spends on the line. (This average is for all the customers who showed up, regardless of whether they are served or not by the end of the day.)

5. (8 points) Lower Mainland Bank is considering opening a drive-through window for customer service. Management estimates that customers will arrive at the rate of 15 per hour. The teller who will be staffing the window can service customers at the rate of one every three minutes. Assuming Poisson arrivals and exponential service, find

   (a) (1 point) Utilization of the teller.

   (b) (1 point) Average number in the waiting line.

(c) (1 point) Average number in the system.

(d) (1 point) Average waiting time in line.

(e) (1 point) Average waiting time in the system including service.

(f) (1 point) Probability that the time between two successive arrivals exceeds 5 minutes.

(g) (2 points) Suppose now that the service times are deterministic (at the same rate). Which of the above answers would change, and what would be the new values for these answers?

6. (4 points) Here are the precedence requirements, normal and crash activity times, and normal crash costs for a project.

	Preceding	Time (Weeks)		Cost ($)	
Activity	Activities	Normal	Crash	Normal	Crash
A	none	7	6	7,000	8,000
B	A	3	2	5,000	7,000
C	A	4	3	9,000	10,200
D	B and C	5	4	3,000	4,500
E	D	2	1	2,000	3,000
F	D	4	2	4,000	7,000
G	E and F	5	4	5,000	8,000

(a) (2 points) What is the estimate completion time without any crashing (assuming that the project is completed as soon as possible)? Justify your answer.

(b) (2 points) To shorten the project by four weeks, which tasks would be shortened and what would be the cost associated with shortening the project by four weeks (i.e., the additional cost compared to the case without any crashing)?