

National Exams May 2004
Ind-A4 - Production Management

3 hours duration

Notes:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made;
2. This is a CLOSED BOOK EXAM.
No Calculators Permitted.
3. FIVE (5) questions constitute a complete exam paper. You definitely have to choose questions 5 and 6; and any three from questions 1 to 4.
4. Each question is of equal value.

You must answer any **three** questions from questions 1, 2, 3 or 4.

Q-1. Kugellager, Inc. makes ball bearings, which are purchased for use by your company. Each ball bearing that you purchase costs 11 cents. You have estimated that you incur fixed costs of \$50 each time you place an order with Kugellager, Inc. Your company uses an annual interest rate of 25% to compute holding costs, and you use approximately 40,000 ball bearings per year at a constant rate.

a) How many ball bearings should you order from Kugellager, Inc., in order to minimize your costs?

b) Under the optimal policy, how many orders do you place, on average, with Kugellager, Inc., over the course of one year? What is the annual cost of this optimal policy?

c) Suppose that Kugellager, Inc., offers you the following incremental discount: You can receive a 2 cent discount for every ball bearing that you purchase over 10,000 ball bearings. Now, what is your optimal order quantity? How much (if any) do you save annually by being able to take advantage of the quantity discount?

d) To get the incremental discount, Kugellager, Inc., informs you that your order will require 10 months from the time it is placed for order to arrive at your facility. What is the optimal reorder point?

Q-2. The city of Valentine, Nebraska, (located in the “heart” of the Sandhills), is preparing for the annual Valentine’s Day rush. In particular, the Valentine post office is famous for the special heart-shaped mailing labels it puts on letters sent through its office during the week before February 14. The post office must decide how many heart-shaped labels to order. Since these labels are quite unique, the supplier only allows the post office to place one order. The unit cost of the labels is \$0.10, and the post office charges \$0.35 for the labels. Any labels not used on Valentine’s Day will be discarded (since there will be a new heart design introduced for next year’s Valentine’s Day).

a) Suppose the sales of heart-shaped mailing labels are normally distributed with mean 3000 and standard deviation of 200. What is the optimal number of labels that should be ordered?

b) Now suppose that the sales of labels are equally likely to be anywhere from 2000 to 4000 labels. How many labels should be ordered? Hint: The p.d.f. of the uniform distribution is $f(x) = 1/(b-a)$ for all x in the interval (a,b) .

c) Explain the difference in the order quantities in part (a) and part (b). Note that in parts, the mean demand was 3000 labels!

Q-3. A product experiences deterministic, time-varying demand. Determine the optimal lot-sizes for the product. What is the cost of the optimal policy?

Period (t)	1	2	3
Demand (D_t)	15	25	45
Unit Cost (c_t)	10	10	10
Holding Cost (h_t)	1	1	3
Setup Cost (A_t)	100	120	80

Q-4. Consider a situation where demand for an item is known and constant over time. Placing an order for these items incurs a fixed cost of A , regardless of the size of the order. The per unit cost of the item is c and it has been estimated that it costs you h per unit per period to hold the item in inventory. Demand for the item is D per period. Once an order is placed, items arrive instantaneously. Orders are placed once a maximum backlog of b units is reached. You estimate that backlogging of inventory results in a cost of p per unit per period. Let:

Q = order quantity

H = maximum on-hand inventory

T = cycle time

- a) Draw and label a graph of the inventory level as a function of time for one cycle.
- b) What is H^* , the optimal maximum on-hand inventory?
- c) What is the average inventory level?
- d) What is the average backorder level?
- e) What is the average cost per period as a function of the order quantity and maximum backorders, $Y(Q, b)$?
- f) What is the optimal number of backorders, b^* ? (You may leave this in terms of the optimal inventory level, Q^*)

You must answer question number 5 and 6.

Q-5. Consider the following flow shop with 6 jobs.

<u>Jobs</u>	<u>Processing Time on Machine 1</u>	<u>Processing Time on Machine 2</u>
1	12	8
2	4	8
3	2	2
4	10	4
5	2	8
6	6	10

- Determine the schedule that minimizes the makespan.
- Draw the associated Gantt chart.
- Calculate the mean flow time for the schedule you found in part (a).

Q-6. Consider the following jobs to be sequenced on a workcenter.

<u>Jobs</u>	<u>Processing Time</u>	<u>Due Date</u>
1	5	10
2	9	23
3	9	14
4	11	39
5	8	18
6	4	21

- Determine the sequence of jobs that minimizes mean lateness.
- Determine the sequence of jobs that minimizes the total number of tardy jobs.