National Exams December 2019

16-Mec-B4, Integrated Manufacturing Systems

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 an OPEN BOOK exam. Any non-communicating calculator is permitted.
3. Any five (5) questions constitute a complete paper. Only the first five (5) questions as they appear in your answer book will be marked.
4. All questions are of equal value.
5. Some questions require an answer in essay format. Clarity and organization of the answer are important.

Question 1:

a) The following table summarizes basic failure rate data on components in an electronic subsystem:

Component	Quantity	Failure Rate Per Hour
Silicon transistor	40	74.0×10^{-6}
Film resistor	100	3.0×10^{-6}
Paper capacitor	50	10.0×10^{-6}

Estimate the mean time between failures. (Assume an exponential distribution. All components are critical for subsystem success.)

b) A system consists of subsystems A, B, and C. The system is primarily used on a certain mission that lasts 8 hours. The following information has been collected:

Subsystem	Required Operating Time During Mission	Type of Failure Distribution	Reliability Information
A	8 hours	Exponential	50% of subsystems will last at least 14 hours
B	3 hours	Normal	Average life is 6 hours with a standard deviation of 1.5 hours
C	4 hours	Weibull with $\beta = 1.0$	Average life is 40 hours

Assuming independence of the subsystems, calculate the reliability for a mission.

Question 2:

a) A manufacturer of dustless chalk is concerned with the density of his product. Previous analysis has shown that his chalk has the required characteristics only if the density is between 4.4 gm/cc and 5.0 gm/cc. If a sample of 100 pieces gives an average of 4.8 gm/cc and a standard deviation of 0.2, is his process aimed at the proper density? If not, what should the aim be? Is the process capable of meeting the density requirements?

b) An instrument has been used to measure the length of a part. The result was 2.638 inches. An error of measurement study was made on the instrument with the following results:

Accuracy: +0.001 inch (on the average, the instrument reads 0.001 inch high)
Precision: 0.0004 inch (1 standard deviation)

Make a statement concerning the true value of the part just measured. State all assumptions needed.

Question 3:

a) What are the categories of forecasting techniques? Generally, how do they differ from each other?

b) Monthly demand (in thousands) for component parts is as follows:

First Year		Second Year	
Month	Demand	Month	Demand
1	10	1	12
2	8	2	11
3	7	3	11
4	4	4	8
5	5	5	10
6	9	6	17
7	12	7	22
8	19	8	27
9	25	9	32
10	29	10	33
11	19	11	21
12	15	12	19

i) Plot these observations.
ii) Estimate the best methods of forecasting future demands.

Question 4:

a) Suppose that we are considering the installation of a small computer to accomplish internal tasks of payroll computation, invoicing, and other routine accounting. The purchase price is quoted as $300,000 and the salvage value five years later is expected to be $100,000. The operating costs are expected to be $100,000 per year, mainly for personnel to program, operate, and maintain the computer. What is the present value of the costs to own and operate the computer over its five-year economic life? The value of money in the organization is 15%.

b) An aggressive marketer of a new office copier has made its machine available for sale as well as lease. The idea of buying a copying machine seems revolutionary, but less so when we examine our present costs, which come to $6,500 per year for lease plus per copy charges of 2 cents per page. If we own a machine, the cost of paper and maintenance is projected to be $1,500 per year. The new copier costs $10,000, installed, and is assumed to have an economic life of five years and a salvage value of $2,000. (assume 50,000 pages per year).

i) What is the projected unadjusted rate of return if we install the copier?

ii) If incremental taxes for the project are $1,000, what is the adjusted rate of return?

Question 5:

Consider a robot cell with machines B, C, and D. An input conveyor brings the part to the pick up point A and the output conveyor is represented by point E. Each part undergoes an operation on B, followed by C, and followed by D. The operation times on B, C, D are given by 9.1, 9.0, and 5.0 min., respectively. Also, the gripper pull-up time = 0.1 min, and the gripper release time = 0.1 min. The robot move times in minutes are given by the table below. Compute the cycle time and the production rate for this system.

	To				
From	A	B	C	D	E
A	-	0.3	0.6	0.9	1.2
B	0.3	-	0.3	0.6	0.9
C	0.6	0.3	-	0.3	0.6
D	0.9	0.6	0.3	-	0.3
E	1.2	0.9	0.6	0.3	-

How will cycle time and production rate change if there are two robots, with robot 1 handling all operations from A to C and robot 2 handling all operations from C to E?

Question 6:

a) A firm expects to decrease manufacturing costs from $12.50 to $11.80 per unit. If fixed costs are $15,000 and the price of the item is $20.00, what is the current break-even point? What would be the new break-even point? If the firm desires to maintain the same break-even point, what is the new selling price?

b) SRA Inc. currently has annual profits of $150,000 on sales volume of $1,000,000 and a fixed cost of $250,000. They are considering purchasing a new system that would provide faster delivery. The equipment reduces variable cost of 20 percent but increases fixed cost by 10 percent. If sales volume is constant, by how much do profits change? If sales increase by 5 percent in the first year due to the more rapid deliveries, what would profits be?

Question 7:

Job orders are received at a work centre with the characteristics indicated by the data in Table 1. In what sequence should the orders be processed at the work centre if the priority dispatch decision rule is:

a) FCFS (first come-first served)?
b) SOT (shortest operation time)?
c) SS (static slack, i.e. due date less time of arrival at work centre)?
d) FISFS (due date system, first in system-first served)?
e) SS/RO (static slack/remaining number of operations)?

Compute priorities for each rule and list the sequence in which orders would be processed. Which decision rule do you prefer? Why?

Order Number	Due Date	Date and Time Received at Centre	Operation Time, Hours	Remaining Operations
1	May 1	April 18, 9 am	6	3
2	April 20	April 21, 10 am	3	1
3	June 1	April 19, 5 pm	7	2
4	June 15	April 21, 3 pm	9	4
5	May 15	April 20, 5 pm	4	5
6	May 20	April 21, 5 pm	8	7