

National Exams December 2018

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 is important.

Question 1:

- a) A large manufacturer of watches makes some of his/her own parts and buys some parts from a vendor. The vendor submits lots of parts that meets the specifications of the horologist. The vendor thus wishes to keep a continuous check on his/her production of watch parts. One gear has been a special problem. A check of 25 samples of 5 pieces gave the following data on a key dimension:

$$\bar{X} = 0.125 \text{ inch} \quad \bar{R} = 0.002 \text{ inch}$$

What criterion should be set up to determine when the process is out of control? How should this criterion compare with the specifications? What are the alternatives if the criterion is not compatible with the specification?

Question 2:

The Stamped Metal Products Co. (StaMCo) is considering the manufacture of a special item for the Air Force. After considerable analysis, the company has identified the following costs:

Material	\$0.5 per unit
Tooling	20 hours
Unit direct labour	0.4 hour
Labour rate	\$2 per hour
Factory burden	115% of labour
General and administrative burden	20% of factory cost
Target profit	10% of total cost

Construct a break-even chart on a 10,000 basis with a unit sales price of \$3

Question 3:

- a) The following table summarizes basic failure rate data on components in an electronic system

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

Question 4:

- a) A component is expected to encounter a maximum stress of 40,000 psi. Past data on similar components show that the standard deviation of *strength* is about 10 percent of the average strength. What specification should be set on average strength to achieve a safety margin of 3.0? 4.0? 5.0? (Assume that strength is distributed normally.)
- b) Measurements were made on the bore dimension of an impeller. A sample of 20 from a pilot run production showed a mean value of 9.8576 inches and a standard deviation of 0.00015 inch. All the units functioned properly, and so it was decided to use the data to set specification limits for regular production.

- i) Suppose it was assumed that the sample estimates were exactly equal to the population mean and standard deviation. What specification limits should be set to include 99 percent of production?
- ii) There is uncertainty that the sample and population values are equal. Based on the sample of 20, what limits should be set to be 95 percent sure of including 99 percent of production?

Question 5:

- a) Discuss in greater detail why the volume to be produced has little effect on the design and operation of a system of production planning and control.
- b) Assume you are organizing a small plant for the manufacture of flashlights. How many of the different types of orders would you use? Explain your use of each type.
- c) Compare the advantages of centralized dispatching with those of decentralized dispatching.

Question 6:

- a) Discuss the advantages and disadvantages of numerical control for machine tools.
- b) What are the general characteristics of production jobs in metal machining for which numerical control would be most appropriate?

Question 7:

- a) One of the axes of a robot is a telescoping arm with a total range of 0.7 m. The robot's control memory has a 12-bit storage capacity for this axis of motion. Determine the robot's control resolution for this axis.
- b) A large hydraulically operated, Cartesian coordinate robot has one orthogonal slide with a total range of 1.2m. One of the specifications on the robot's precision of movement is that it has a control resolution of 0.5mm on this slide. Determine the number of bits of storage capacity which the robot's control memory must possess to provide at least this precision.