1. The life of a certain component x is normally distributed with a mean of μ=**30** hours and std deviation σ= **4** hours. a) What is the probability that failure occurs after 26 hours of operation.
b) When should the component be replaced so that the probability of
failure is no more than **5%**.

2. If the probability that a single article will be nonconforming is **0.2,** what is the probability that a sample of **15** such articles will contain:
a) exactly **1** nonconforming item
b) more than **5** nonconforming items.
c) at most 3 nonconforming
Give your answers by both i) the exact probability (use tables) and ii) Poisson approximation.

3. A certain machining operation puts out finished bolts whose diameters have a mean:
μ = 0.440 in. and σ = 0.02 inches. (***Use the table of Control Chart Constants #4 in our class portal***)

a) compute the 3-sigma control limits for the **x-bar and S** charts based on a subgroup size of 9.
b) what is the probability of not detecting a shift in σ **to 0.05** inches on the x-bar chart on the first subgroup sampled after the shift (assume the mean stays the same)?
c) what is the average number of samples (i.e., the expected number) required to detect the shift in b) above? Give your answers to the nearest whole number.

4. A manufacturer of certain subassembly item used in robot control is having difficulty with a particular dimension on the unit. Two automatic screw machines produce the parts at a rate of 100 per hour each. Items from both machines are discharged into a single tote from which a **subgroup of 4** is selected every half-hour. The process appears to be in statistical control with the **3-sigma** control limits for the **X-bar** chart equal to **140 ± 5** units. The s-chart also showed control. The normal distribution applies.
a). Assuming no points are out of control and no runs are apparent, if the buyer of the subassembly components has design spec limits of **139 ± 10,** and **10,000 parts undergo this process**, how many parts will be out of spec.
b). Suppose a sudden shift in the process average increases the mean by **+ 0.25**σ but the process variance remains unchanged, what % of the product will be out of control on the manufacturer's control chart.
What is the probability of detecting this shift by the 4th sample taken after the shift?

5. A control chart for number nonconforming chart (np chart) is to be established based on a sample size of n=400. To initiate the control chart, 30 samples, each of 400 items, were selected were and the number nonconforming tabulated for all 30 samples, yielding the following: $\sum_{i=1}^{30} np = D = 120$

a). Establish the parameters of the np chart (compute $\bar{p}, n\bar{p}, CL, UCL, LCL$)

b). Suppose the fraction nonconforming p shifts to 0.025. What is the probability that the shift would be detected in the first sample taken after the shift has occurred? (Use the Poisson Approximation)

6. A fraction nonconforming chart has center line $\bar{p}$ = 0.1, UCL=0.19, and UCL=0.01.

a). Assuming a 3-sigma chart is used, what is the sample size for the control chart.

b). Use the Poisson approximation to the binomial to find the probability of a Type I error α.

c). Use the Poisson approximation to find the Type II error if the actual fraction nonconforming p=0.2

d). What is the ARL in part c).

e). If it is desired that the UCL should not be more than 0.182, what sample size n will guarantee this value of the UCL. What is the corresponding value for LCL?

7. A careful analysis of the approaches of the three Gurus (Deming, Juran and Crosby) to World Class Quality Culture and Continuous Improvement show six key areas of agreement or convergence.
a). For the signpost of **Strategic planning/Structure** BRIEFLY **discuss and contract** the approach of each of the GURU's to this important signpost especially how it contributes to continuous quality improvement and World Class Quality.

8. Very Brief Answers Required
a). On the X-bar chart, what is the sampling distribution of the random variable for the mean and variance, and why?
b). To determine if the process meets specifications, what is the sampling distribution for the mean and the variance, and why?

9. Sign a pledge indicating that the work you submitted is solely yours and not in collaboration with or in consultation with anyone other than the class instructor.