Large Plant Power Supply

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ELEC 3800 – Fall 2021
ABET Project (CMPE)

ELEC 3800 Random Signals and Systems

ABET Outcome (1) Performance Indicators

1. **Identify problem**: Describe a problem pertinent to the material under study. Why is the problem of interest? How does it pertain to the course material?

   The student will determine the validity of a claim that Kia Motors Manufacturing Plant's average voltage supply is within a certain range for a given confidence level. This problem is of interest in systems engineering where monitoring grid levels are of extreme importance to ensuring the continuous and profitable stream of vehicle production. The problem is an application of hypothesis testing which is taught in Random Signals and Systems.

2. **Formulate problem**: You will create a problem using the course material of sufficient rigor to satisfy the other terms (engineering, science, math) in the outcome statement.
   a. State the homework problem

      In manufacturing plants, relays are used to monitor voltage levels and protect plant equipment from being damaged. If the plant is operating at 100% capacity, the relay sees a voltage supply with a mean of 4000 V every hour. If the voltage rises above 4000 Volts, this will result in a plant shut down. To test this claim, 75 samples are taken at various peak load times throughout the week. The sample mean was determined to be 4032 volts and the sample standard deviation was 62 volts. Is it valid to claim that the plant will continue operating with a 96% confidence level?

   b. What engineering assumptions must be made to solve the problem, if any?
      - Kia Motors Manufacturing Plant draws a constant power supply.
      - Voltage levels above 4000 volts will damage plant equipment.
      - Undervoltage values will not damage plant equipment.

3. **Solve problem**: in a tutorial fashion, show the step-by-step solution process including key assumptions. Your solution should be neatly and logically presented and should yield the correct answer.

   To solve this problem, use hypothesis testing. The following information is given in the problem statement:

   Sample Mean: $\hat{\bar{X}} = 4032\ V$

Sample Standard Deviation: $\tilde{S} = 62\ V$
Number of Samples: n = 75
Confidence Level: 0.96
Expected Mean: $\bar{X} = 4000\ V$

For this case, a one side hypothesis is needed because voltage levels over 4000 will cause a plant shutdown.

H_0: $\bar{X} \leq 4000$
H_1: $\bar{X} > 4000$

Calculate Z:

$$Z = \frac{\hat{\bar{X}} - \bar{X}}{\tilde{S}/\sqrt{n}}$$

$$Z = \frac{4032 - 4000}{62/\sqrt{75}}$$

$$Z = 4.470$$

To calculate the confidence limits (Z_C), use the Q-table.

$$\Pr(-\infty \leq Z \leq z_c)$$

$$F_X(z_c) - F_X(-\infty)$$

$$F_X(z_c) - 0 = \phi(z_c)$$

$$\phi(z_c) = 1 - Q(z_c) = 0.96$$

$$Q(z_c) = 0.04$$

$$z_c = 1.75$$

Conclusion:

Since Z is not less than z_c ($Z \leq z_c$), the null hypothesis should be rejected.

The integrity and reliability of the grid needs to be evaluated in order to ensure the customer stays online. If this is not acted upon, the company may lose a large industrial customer to a competitor.