

**CIE 272**  
*Civil Engineering Measurements*  
Exam #2  
November 14, 2008

**Directions:**

1. Write your name on your exam booklet, NOW!
2. Write all of your answers in the booklet. This exam sheet **will not be graded.**
3. Read the questions carefully. Most errors on timed examinations are the result of not understanding what is being asked.
4. **DON'T PANIC!** If you can't answer a question, it is probably true for your classmates as well!

*Good Luck!*

**1. (25 Points)** Use the standard normal distribution to answer the following questions:

- a. (5) What is  $P(Z \leq +1.83)$  ?
- b. (5) What is  $P(Z > -0.11)$  ?
- c. (5) What is the  $z$  value such that  $P(Z \leq z) = 0.227$  ?
- d. (5) What is  $P(+0.16 \leq Z \leq +1.72)$  ?
- e. (5) What is the  $z$  value such that  $P(-1.16 \leq Z \leq z) = 0.80$  ?

2. **(35 Points)** The design for a road requires a 3-inch thick layer of asphalt. In order to be careful, the contractor sets up the paving machine to lay down 3.2 inches. The standard deviation is known to be 0.2 inches, and the thickness can be assumed to be normally distributed.
- (10) What is the probability that a random sample of the asphalt will have a thickness less than 3.0 inches?
  - (10) What fraction of the road will have asphalt thickness between 3.0 and 3.5 inches?
  - (10) What thickness value represents the 75% percentile?
  - (5) Find the conditional probability that the asphalt is greater than 3.0 inches thick given that it is greater than 2.8 inches thick.

**[Hint:** Remember that  $P(A|B) = \frac{P(A \text{ and } B)}{P(B)}$  ]

3. (40 Points) The construction of a small warehouse can be broken into two phases – the foundation and the superstructure. The foundation must be completed before the superstructure can be started (the phases are **independent**). The work can be done at three different speeds: *express*, *fast*, and *standard*. The speeds affect both the cost and the probability of completion, as outlined in the tables below:

Phase	Speed	Cost (\$1000)	Probability the phase will be completed in:			
			4 months	5 months	6 months	7 months
Foundation	Express	195	0.70	0.30	0	0
Foundation	Fast	162	0.50	0.50	0	0
Foundation	Standard	141	0.30	0.70	0	0

Phase	Speed	Cost (\$1000)	Probability the phase will be completed in:			
			4 months	5 months	6 months	7 months
Superstructure	Express	340	0	0.50	0.30	0.20
Superstructure	Fast	290	0	0.30	0.35	0.35
Superstructure	Standard	225	0	0.10	0.40	0.50

The client would like to have the building completed in 11 months or less, and has a maximum budget of \$500,000.

- (10) If the client chooses the *standard* speed for both phases, what is the probability that the foundation will be completed in 5 months **and** the superstructure will be completed in 6 months?
- (10) If the client chooses the *fast* speed for the foundation phase and the *standard* speed for the superstructure phase, what is the probability that the building will be completed in exactly 10 months?
- (10) If the client chooses the *fast* speed for both phases, what is the probability that the building will be completed in 11 months or less?
- (10) What is the **least expensive** combination of speeds that has a probability of completing the building in 11 months or less of 0.85 or greater?

**Extra Credit (10 Points)** The Monod equation is used to model the growth of bacteria in wastewater treatment plants:

$$\mu = \frac{Q_{\max} \cdot C_x}{K_M + C_x}$$

An experiment has been conducted, in which the growth rate ( $\mu$ ) has been measured for a series of substrate concentrations ( $C_x$ ).

Show how the parameters  $Q_{\max}$  and  $K_M$  can be estimated from a linear plot derived from the measured  $\mu$  and  $C_x$  values. What should be plotted on the x-axis? What should be plotted on the y-axis?