Name: SOLUTION Student #: ______________

Problem 1. (14 points)

For each of the following questions, circle the letter in the right-hand column that corresponds to the best answer.

A. Using the Tail-End Z-function, Z(x), the fraction of the normal distribution between –1.5 σ and +3.0 σ is given by which of the following computations? a b c [✓ d]

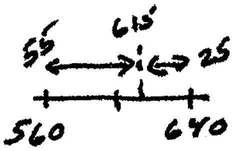
(a) Z(3.0) – Z(1.5)
(b) Z(3.0) + Z(–1.5)
(c) Z(1.5) – Z(3.0)
(d) Z(–1.5) – Z(3.0)

B. The percentage of the normal distribution within ±1.2 standard deviations of the mean is most closely equal to which of the following values? a b [✓ c] d

Z(1.2) = 11.5%

(a) 11.5 %
(b) 23.0 %
(c) 77.0 %
(d) 89.5 %

C. The design specification for a part characteristic is 600 ± 40. The manufacturing process has an actual mean of 615 and a standard deviation of 10. The fraction of parts that are defective (out of spec) is given by which of the following computations? [✓ a] b c d



(a) Z(2.5) + Z(5.5)
(b) 1 – Z(2.5) – Z(5.5)
(c) Z(4.0) + Z(4.0)
(d) (1 – Z(2.5)) + (1 – Z(5.5))

D. The reliability of a system can be increased by adding a redundant element in parallel, provided only one functioning element is required for the system to function correctly and the reliability of the added element is _______ the reliability of the original element. a b c [✓ d]

(a) less than
(b) equal to
(c) greater than
(d) all of the above

E. To improve reliability, a single resistor (of value R) is replaced by the "quadded component" shown (each resistor has the value R). Assuming resistors may fail as either an open-circuit or as a short-circuit, what is the minimum number of resistors that must fail before the quadded component stops functioning as a resistor? a [✓ b] c d

(a) 1
(b) 2
(c) 3
(d) 4

F. Which of the following is not a possible equivalent resistance for the quadded component from question E, after it "partially fails" but still functions as a resistor? a b [✓ c] d

(a) R / 2 $R \parallel R$
(b) 2R / 3 $(R+R) \parallel R$
(c) 3R / 2
(d) 2R $(R+R) \parallel$ open

G. Which of the following steps is not required to become a registered (licensed) professional engineer? [✓ a] b c d

(a) complete a master's degree
(b) work as an engineer
(c) pass the Fundamentals of Engineering exam
(d) pass the Principles and Practices exam

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Problem 2. (16 points)

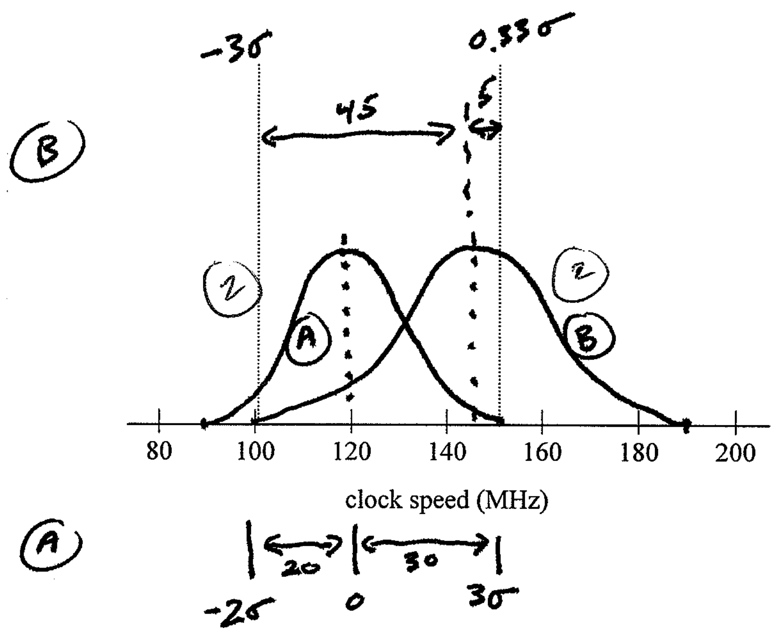
Just as manufacturers may use "binning" to select components close to a desired value, "speed grading" may be used to identify microprocessors that will work correctly at faster speeds, so that they can be sold for a higher price. Assume a manufacturer wishes to sell a particular microprocessor, with two possible speeds: 100 MHz and 150 MHz. Each chip is first tested at 150 MHz; those that fail are then tested again at 100 MHz. Chips that fail the second test are discarded, while the others are labeled based on the speed at which they passed the test.

While the manufacturing process is intended to produce devices that work at a particular clock speed, assume that the highest speed at which a specific chip will function is normally distributed. A and B, below, describe the distribution of maximum clock speeds for two possible manufacturing processes.

A. Actual mean: 120 MHz Standard Deviation: 10 MHz

B. Actual mean: 145 MHz Standard Deviation: 15 MHz

Using the axis provided below, sketch both distributions (label the curves "A" and "B"). For each option, compute the following values: percent sold as 150 MHz, percent sold as 100 MHz, and percent discarded. Write your answers in the boxes at the right margin. *Show your work*; if you need more space, use the back of this page.



Process A:

150 MHz	0.135 %
100 MHz	97.59 %
Discarded	2.275 %

Process B:

150 MHz	37.07 %
100 MHz	62.795 %
Discarded	0.135 %

Ⓐ 150: Z (3.0) = 0.135 %

DIS: Z (2.0) = 2.275 %

100: 100 − 0.135 − 2.275 = 97.59

Ⓑ 150: Z (0.33) = 37.07 %

DIS: Z (3.00) = 0.135 %

100: 100 − 37.07 − 0.135 = 62.795

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Problem 3. (12 points)

Answer each of the following questions by circling either TRUE or FALSE in the left-hand column.

TRUE	[✓ FALSE]	The primary purpose of accelerated stress testing is to reduce the failure rate during the "useful lifetime" of a product.
[✓ TRUE]	FALSE	Under normal economic circumstances, the present value of a future transaction decreases as the time interval increases.
[✓ TRUE]	FALSE	The "utilitarian" model of morality emphasizes maximizing the benefit of a decision; i.e., "the most good for the most people".
TRUE	[✓ FALSE]	One of the major advantages of experiment-based design methods is that they produce globally-optimal solutions.
[✓ TRUE]	FALSE	Engineering licensure was instituted by states to protect the life, health, and property of the general public.
[✓ TRUE]	FALSE	The use of sampling techniques to characterize a product or process is more accurate for parameters that have a small standard deviation.
TRUE	[✓ FALSE]	Most engineering disasters have a single, identifiable cause and could have been avoided by better design.
[✓ TRUE]	FALSE	Given a geometric gradient series of payments over n years, there is always a uniform series of payments over n years that has the same present value.
[✓ TRUE]	FALSE	One of the major causes of failures during the "infant mortality" period is latent defects that were not detected during the manufacturing process.
TRUE	[✓ FALSE]	The "rights-based" model of morality is based on your right to act in your own best interest.
[✓ TRUE]	FALSE	One of the major advantages of experiment-based design methods is that they can produce designs that are tolerant of normal manufacturing variation.
[✓ TRUE]	FALSE	Given the tail-end Z-function, Z(x), the cumulative distribution function can be computed as follows: CDF(x) = Z(–x).