Name: ________________________________ Recitation Section: **L**__________

Student Number: ______________________________

1. Check that your exam includes all 5 pages.
2. Read all instructions and problems carefully. Points will be deducted for failure to follow instructions.
3. Complete the information requested in the spaces above.
4. PRINT your name and student number in the spaces at the top of all remaining pages of this exam.
5. The back of this cover page is a data sheet containing formulas and a Z-table.
6. **Show ALL of your work on these pages.** The pages in this exam may be separated for grading; therefore, if you need extra space for a particular problem, write on the back of the page for that problem. The instructions for a specific question may limit the amount of space allowed for an answer.
7. You are permitted one sheet (8½ x 11), double-sided of **handwritten** notes. Use of any other notes, books, or other resources is prohibited.
8. Calculators are permitted; however, you are not allowed to use the calculator memory to store notes, etc.
9. This exam lasts for 45 minutes. Point values are listed for each problem to assist you in best using your time.

__________	Problem 1.	(14 points possible)
__________	Problem 2.	(10 points possible)
__________	Problem 3.	(16 points possible)
__________	Problem 4.	(10 points possible)
__________	**TOTAL**.	(50 points possible)

Name: ____ 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. The percentage of the normal distribution more than 1.5 standard deviations away from the mean is most closely equal to which of the following values? **a b c d**

(a) 6.7 % (c) 86.6 %
(b) 13.4 % (d) 93.3 %

B. A manufacturing line produce microprocessors whose average maximum operating clock speed is 150 MHz. Assuming a normal distribution of maximum operating speeds and a standard deviation of 30MHz, approximately what percentage of microprocessors will operate correctly at 200 MHz? **a b c d**

(a) less than 1 % (c) 5 %
(b) 2 % (d) 10 %

C. A manufacturing process has an average defect rate of 1.8 defects per unit. What is probability that a particular unit will have 3 defects? **a b c d**

(a) 0 % (c) 5.8 %
(b) 5.4 % (d) 16.1 %

D. A manufacturing process has a first-time yield (FTY) of 92.4%. While producing 1000 good units, approximately how many defective units will be manufactured? **a b c d**

(a) 0 (c) 82
(b) 76 (d) 92

For each of the following statements, circle the appropriate response in the right-hand column.

E. Professional engineers are licensed by the US government and may legally practice in all 50 states. **TRUE FALSE**

F. Given a geometric gradient series of payments over n years at interest rate i, there is an arithmetic gradient series of payments also over n years at interest rate i that has the same value. **TRUE FALSE**

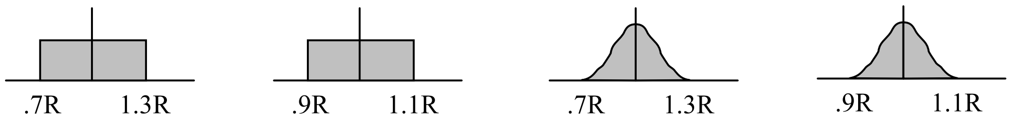
G. The failure of the walkways in the Hyatt Regency hotel was primarily the result of errors in the original design specifications. **TRUE FALSE**

Name: ______________________________ Student #: ____________________

Problem 2. (10 points)

Three resistors (R1, R2, and R3) are connected in series to form a resistance R = R1 + R2 + R3.

A. (2 points) Assume R1, R2, and R3 are randomly selected from large supplies of resistors manufactured to provide a uniform distribution of resistor values within ± 10% tolerance. Which of the following figures most closely describes the expected distribution of values for R? Circle the best response.



B. (2 points) Assume R1, R2, and R3 are randomly selected from large supplies of resistors manufactured to provide a normal (Gaussian) distribution of resistor values, with ± 3σ = ± 10% of the resistor value. How would the standard deviation of the expected distribution of values for R under these conditions compare to the standard deviation of the expected distribution of values for R under the conditions in part A? Circle the best response.

* Less than in part A
* Greater than in part A
* Approximately the same as in part A
* Cannot be determined from the information provided

In lecture, the design of an RLC filter bank was described as an example of using experiment-based design methods to determine component values and tolerances.

C. (3 points) Identify and briefly describe at least two significant advantages of experiment-based design compared to traditional design methods (e.g., critical path, worst case) for determining component values and tolerances.

D. (3 points) Identify and briefly describe at least two significant limitations or weaknesses of experiment-based design compared to traditional design methods (e.g., critical path, worst case) for determining component values and tolerances.

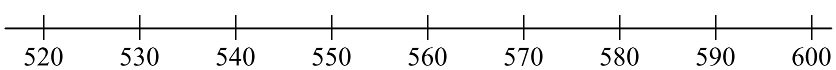
Name: ____________________ Student #: ____________________

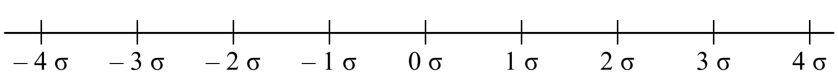
Problem 3. (16 points)

E. (10 points) Complete the following table. Assume design specifications are symmetric around the target mean and that the characteristics of the manufactured item are distributed according to a normal (Gaussian) distribution. You must show your calculations in the space below (or on the back of *this* page) in order to receive full credit.

Lower Spec Limit	**Target Mean**	**Upper Spec Limit**	**Actual Mean**	**Standard Deviation**	**Cp**	**Cpk**	**Defective (Below LSL)**	**Defective (Above USL)**
	565		559		0.8	0.6		
	0 σ			σ			Z(4.1) ≈ 0.0021%	Z(3.1) ≈ 0.0968%

F. (6 points) Using the axes provided, sketch these situations in the spaces below. Include (and label) the target value, upper and lower specification limits, the actual mean, and the probability distribution curve.





Name: ____ Student #: ____________________________

Problem 4. (10 points)

A. (3 points) In the lecture on environmental and sustainability issues, an example was presented about how information technology can be used to make industrial plants run more efficiently than plants controlled by "hard-hatted guys with big wrenches running around adjusting valves as a supervisor scanned a wall full of hydraulic gauges". In this example, "two young engineers talked their boss into letting them buy a $200 portable computer on which they wrote a simple program to help optimize the plant's operations. Their initiative saved millions of dollars in the first year. " (from *Natural Capitalism*, by Hawken, Lovins, and Lovins, Little, Brown, 1999)

From what academic institution had the engineers graduated? ____________________________

From where did they purchase the portable computer? ____________________________

For what company did the engineers work? ____________________________

B. (7 points) Answer and provide a brief, but non-trivial, defense of your answers to the following: List a minimum of three values that people from various worldviews agree form an ethical basis, and elaborate on the reasons for at least one of these. To whom are you responsible as an engineer? Why should an engineer behave ethically?

Legibly write your answers on the lines below. You are limited to the space provided on these lines. ***DO NOT*** *write (or continue) your answers in the margins, on the back of this page, or anywhere else on this exam. Your answers will be graded on both appropriateness/correctness and on the quality/clarity of your writing. A longer answer is not necessarily a better answer.*

Engineering Economics Formulas

$$(F/P, i\%, n) = (1 + i)^n \qquad (P/F, i\%, n) = \frac{1}{(1 + i)^n}$$

$$(A/F, i\%, n) = \frac{i}{(1 + i)^n - 1} \qquad (F/A, i\%, n) = \frac{(1 + i)^n - 1}{i}$$

$$(A/P, i\%, n) = \frac{i\,(1 + i)^n}{(1 + i)^n - 1} \qquad (P/A, i\%, n) = \frac{(1 + i)^n - 1}{i\,(1 + i)^n}$$

$$(P/G, i\%, n) = \frac{(1 + i)^n - (i \bullet n) - 1}{i^2\,(1 + i)^n}$$

$$(P/F_1, i\%, g\%, n)\ (i \neq g) = \frac{(1 + i)^n - (1 + g)^n}{(i - g)\,(1 + i)^n} \qquad (P/F_1, i\%, g\%, n)\ (i = g) = \frac{n}{(1 + i)}$$

Manufacturing-Related Formulas

$Cp = (USL - LSL) / (6\,\sigma)$ $\quad Cpk = Cp\,(1 - k),\ k = |\text{Actual Mean} - \text{Target Mean}| / ((USL - LSL) / 2)$

First-time yield, $FTY = e^{-dpu}$ $\quad$ Prob { k defects } $= (dpu^k / k!)\, e^{-dpu}$

Tail-End Z-Table (excerpt)

Z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.50	.308538	.305026	.301532	.298056	.294598	.291160	.287740	.284339	.280957	.277595
0.60	.274253	.270931	.267629	.264347	.261086	.257846	.254627	.251429	.248252	.245097
0.70	.241964	.238852	.235762	.232695	.229650	.226627	.223627	.220650	.217695	.214764
0.80	.211855	.208970	.206108	.203269	.200454	.197662	.194894	.192150	.189430	.186733
0.90	.184060	.181411	.178786	.176186	.173609	.171056	.168528	.166023	.163543	.161087
1.00	.158655	.156248	.153864	.151505	.149170	.146859	.144572	.142310	.140071	.137857
1.10	.135666	.133500	.131357	.129238	.127143	.125072	.123024	.121001	.119000	.117023
1.20	.115070	.113140	.111233	.109349	.107488	.105650	.103835	.102042	.100273	.098525
1.30	.096801	.095098	.093418	.091759	.090123	.088508	.086915	.085344	.083793	.082264
1.40	.080757	.079270	.077804	.076359	.074934	.073529	.072145	.070781	.069437	.068112
1.50	.066807	.065522	.064256	.063008	.061780	.060571	.059380	.058208	.057053	.055917
1.60	.054799	.053699	.052616	.051551	.050503	.049471	.048457	.047460	.046479	.045514
1.70	.044565	.043633	.042716	.041815	.040929	.040059	.039204	.038364	.037538	.036727
1.80	.035930	.035148	.034379	.033625	.032884	.032157	.031443	.030742	.030054	.029379
1.90	.028716	.028067	.027429	.026803	.026190	.025588	.024998	.024419	.023852	.023295
2.00	.022750	.022216	.021692	.021178	.020675	.020182	.019699	.019226	.018763	.018309
2.10	.017864	.017429	.017003	.016586	.016177	.015778	.015386	.015003	.014629	.014262
2.20	.013903	.013553	.013209	.012874	.012545	.012224	.011911	.011604	.011304	.011011
2.30	.010724	.010444	.010170	.009903	.009642	.009387	.009137	.008894	.008656	.008424
2.40	.008198	.007976	.007760	.007549	.007344	.007143	.006947	.006756	.006569	.006387
2.50	.006210	.006037	.005868	.005703	.005543	.005386	.005234	.005085	.004940	.004799
2.60	.004661	.004527	.004397	.004269	.004145	.004025	.003907	.003793	.003681	.003573
2.70	.003467	.003364	.003264	.003167	.003072	.002980	.002890	.002803	.002718	.002635
2.80	.002555	.002477	.002401	.002327	.002256	.002186	.002118	.002052	.001988	.001926
2.90	.001866	.001807	.001750	.001695	.001641	.001589	.001538	.001489	.001441	.001395
3.00	.001350	.001306	.001264	.001223	.001183	.001144	.001107	.001070	.001035	.001001