Name: _____ Recitation Section: **L**

Student Number: _____

1. Check that your exam includes all 7 pages (cover, 6 problems, and one 2-sided formula sheet).
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. **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.
6. You are permitted one sheet (8 1/2 x 11, double-sided) of **handwritten** notes. Use of any other notes, books, or other resources is prohibited.
7. Calculators are permitted; however, you are not allowed to use the calculator memory to store notes, etc.
8. This exam lasts for 50 minutes. Point values are listed for each problem to assist you in best using your time.

_____	Problem 1.	(20 points possible)
_____	Problem 2.	(10 points possible)
_____	Problem 3.	(12 points possible)
_____	Problem 4.	(20 points possible)
_____	Problem 5.	(20 points possible)
_____	Problem 6.	(20 points possible)
_____	**TOTAL**.	(100 points possible)

Manufacturing-Related Formulas

$Cp = (USL - LSL) / (6\ )$ $Cpk = Cp\,(1 - k)$

$k = |\text{ Actual Mean} - \text{Target Mean }| / ((USL - LSL) / 2)$

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

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Problem 1. (20 points)

An electronic production process requires a specific solder joint to have a resistance less than 4×10^{-6} ohms. Three batches of 100,000 devices, each device containing exactly one of these joints, are produced, with a mean and standard deviation of

Batch A: mean= 2.2×10^{-6} ohms

Standard deviation = 10^{-6} ohms

Batch B: mean= 3.0×10^{-6} ohms

Standard deviation= 1.5×10^{-6} ohms

Batch C: mean= 2.5×10^{-6} ohms

Standard deviation= 2.5×10^{-6} ohms

Which batch has the least number of expected defects, and what is that expected number? Justify your answer.

Batch_____

Number=_____

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Problem 2. (10 points)

For each of the vocabulary words on the left, select the most appropriate descriptive phrase from the list on the right. Each phrase may be used only once.

A. Stockholder Equity _____

B. Venture Capital _____

C. Retained Earnings _____

D. Corporate Bond_____

E. Liquidating Value _____

(a) Net Earnings minus Dividends (net = after tax)

(b) Cash available to fund the early development of a company

(c) Certificate of debt owed by company

(d) Owners' claim on assets of corporation

(e) Amount available if operations of corporation cease

Problem 3. (12 points)

A manufacturing process is characterized by the following values:

Cp = 1.6 Cpk = 1.2 Target mean = 420 Actual mean = 460

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. Compute the values specified below. You must show your calculations in the space below (or on the back of *this* page) in order to receive full credit.

Lower specification limit: _____

Upper specification limit: _____

Standard deviation: _____

Defects below LSL (in terms of tail-end Z function): _____

Defects above USL (in terms of tail-end Z function): _____

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Problem 4. (20 points)

Solar cell modules are being tested for extended use. There is an initial basic functional test that detects all (coverage = 100%) manufacturing defects. It is found that 10% of the solar cells fail this initial test, and those are rejected and scrapped. A solar cell module may have more than one defect and the defects are Poisson distributed. Answer each of the following questions about this product. For full credit you must provide a numeric answer **and** show your work to derive that value.

a) What is the average number of defects per solar cell module built?

b) What is the average number of defects per defective solar cell module?

c) Solar cells that pass the initial test will still fail during normal operation because of wear-out. Assume the failure rate is described by a constant per unit failure rate of 0.2 per year. What fraction of the initially good cells are still functioning after two years?

d) Assume that the price of a maintenance contract for a large solar roof panel assembly is $2000 the first year, and that this cost increases 5% per year. Determine the equivalent present cost of the maintenance contract over a 20-year period, assuming an interest rate of 8%?

e) Solar technology has been mentioned as related to the concept of sustainability in engineering. What would be two concerns relating to this technology from a sustainability viewpoint?

_____

_____

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Problem 5. (20 points)

Following are 10 statements. For each of the following statements, circle the appropriate response in the right-hand column. This problem is scored by # of points=2 (number correctly circled) – 1 (number incorrectly circled). In other words, incorrect guesses hurt worse than no guesses.

A.	For the afternoon portion of the Fundamentals of Engineering Exam, one must take **a** discipline specific exam.	**TRUE**	**FALSE**
B.	Under the doctrine of strict liability, negligence must be proved before a corporation is legally liable.	**TRUE**	**FALSE**
C.	The failure of the walkways in the Hyatt Regency hotel was primarily the result of errors in the original design specifications.	**TRUE**	**FALSE**
D.	It is possible to obtain a patent without a working model.	**TRUE**	**FALSE**
E.	One of the purposes of Quality Function Deployment (QFD) is to identify conflicting customer needs and desires.	**TRUE**	**FALSE**
F.	The cash flow of a corporation is approximately equal to the net earnings minus the non-cash expenses	**TRUE**	**FALSE**
G.	A patent application must disclose enough information for the idea to be duplicated by others, and the patent application is publicly available.	**TRUE**	**FALSE**
H.	In design for manufacturability, the value of Cp should be made as small as possible.	**TRUE**	**FALSE**
I.	A system composed of a highly reliable subsystem in parallel with a weakly reliable subsystem is always less reliable than the highly reliable subsystem alone.	**TRUE**	**FALSE**
J.	The infant mortality region of the "bathtub" model of device reliability is typically characterized by a constant per-unit failure rate.	**TRUE**	**FALSE**

Scoring: _____ correct answers x 2pts = _____

minus number of incorrect answers – _____

Score:

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Problem 6. (20 points)

A. (10 points) Two alternative designs for a space comuunication project, with sub-assembly reliabilities, are shown. Determine the reliability of each alternative.

Alternative #1

Alternative #2

R1=_____ R2=_____

B. (10 points) Because of launch uncertainty, there are two possible profit outcomes for the two alternatives. Using a decision theory model, and assuming that neither alternative fails, which alternative should the company purchase? Assume a useful life of 8 years, after which the systems are useless. An interest rate of 6% is assumed for the calculations. Show all calculations. Note: an approximate calculation may be useful.

Cost of alternative #1= $2.0 million

Launch Condition A (probability =.6). Net revenue from #1=$310,000 per year

Launch Condition B (probability =.4). Net revenue from #1=$280,000 per year

Cost of alternative #2= $2.0 million

Launch Condition A (probability =.2) Net revenue from #2=$300,000 per year

Launch Condition B (probability =.8) Net revenue from #2= $600,000 per year the first four years, and zero the last four years.

Alternative # _____