MECH.5760 EPM Midterm Exam Even 7th Digit. Name: **Kunal Nandanwar (02049382)**

Please answer only one question depending on your student ID last (end) digit

Submit only the questions and your answers for your quiz version to lessen the amount of paper

Please show background formulas and calculations for math problems. No credit if no backup data is provided.

1.1 (Please answer only one question depending on your last digit on your UML ID)

2. A part is specified with a tensile strength 2 sided specifications.

It has a Cp = 0.7. Please determine the reject rate. RR = **35720 ppm**

$$Cp = \pm\frac{SL}{3\sigma}$$

Therefore, $$SL = \pm\, Cp * 3\sigma$$

$$SL(\text{Cp} = 0.7) = \pm\, 0.7 * 3\sigma = \pm\, \mathbf{2.1\sigma}$$

Using Standard Distribution Chart (which is symmetric, hence Z= - Z) to find the expected reject rate:

Z	f(Z)	One sided	Two-sided
-2.1 (or 2.1)	0.01786	17860 ppm	35720 ppm

1.2. (Please answer only one question depending on your last digit on your UML ID)

2. A pull test for aluminum is conducted with strength minimum only (no maximum specification). The reject rate is 0.6%. Please determine the Cp and Cpk of the pull test. (Assume average is centered = N)

Cp = **0.8366**; Cpk = **0.8366**

Since average is centered => $Cp = Cpk$

Reject rate: 0.6 /100 = **0.006** (for 1-sided)

From Standard Distribution Chart: f(Z) = 0.006 => **Z = -2.51(approx.)**

Therefore,

$$Cp = Cpk = \frac{Z}{3} = \frac{2.51}{3} = \mathbf{0.8366}$$

1.3 (Please answer only one question depending on your last digit on your UML ID).

If there is no applicable answer, please indicate by placing N/A.

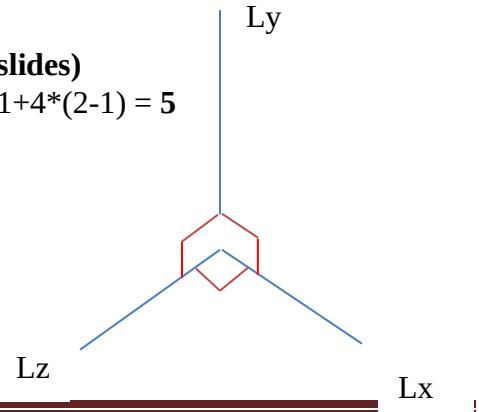
2. A design of experiment is to be performed on 4 factors and two levels. How many experiments do you need to do? Please specify the orthogonal experiment, using the nomenclature Lx.

Full factorial **16** , 1/2 factorial (half Fraction) **8** , Saturated (Screening Design) **8**

1. Full factorial: No of experiments = 2^4 **= 16**
2. Half factorial: No of experiments = 2^{4-1} **= 8**
3. Saturated: No of experiments = **8 (using slides)**
4. Total number of experiments: $1 + factors * (level - 1)$ =1+4*(2-1) = **5**

Orthogonality means that all estimates can be obtained independently of one another, and it is critical for experiment design.

Lx, Ly, and Lz are 3 mutually perpendicular axes which represent orthogonal design.



2.1 (Please answer only one question depending on your last digit on your UML ID)
Give 3 differences (Maximum) between the following: Limit yourself to one paragraph, max 6 lines:
Please list the reasons separately as items 1, 2 and 3.

2. Maturity versus Commodity products

Maturity	Commodity
1. A product is called maturity product when it is in the maturity stage of the cycle (i.e., Growth -> Maturity ->Decline)	1. A product is called commodity when it is an input or a basic product in the production line (i.e., products are in fact made using commodities)
2. Value to the product can be added in the maturity stage	2. Value can not be added to a commodity
3. A maturity product is available in a polished state	3. A commodity is always available in a natural state

2.2 (Please answer only one question depending on your last digit on your UML ID)
Briefly Discuss the attribute of Product lifecycle Stages in Design and Manufacturing. Please limit yourself to one paragraph, max 6 lines. **Please list attributes separately as items 1, 2 and 3**

2. Maturity Stage

1. During this stage, companies face several different challenges and try to retain or establish their market share
2. It is a stage in which the sales growth slows down after reaching a peak
3. In this stage, decreasing market share and declining profits are often observed in this stage
4. This stage lasts longer than the growth stage/startup stage
5. This is also a stage in which the product competes against other similar products
6. Leading the company to increase advertisements and marketing of products

3.1 (Please answer only one question depending on your last digit on your UML ID)
Briefly give three (Max) differences between the methods of the following. Limit yourself to one paragraph, max 6 lines. **Please list the differences separately as items 1 and 2 (except for questions 8/9).**

2. World Class versus Best-in-Class Company performance

World Class Company Performance	Best-in-Class Company Performance
1. There are the companies which provide the best possible product at the best possible price when the customer needs it	1. They thoroughly study the market of a product & design their own version of a product which beats the existing competitors in the market
2. Driven to a single vision and a shared goal among employees which is to deliver the optimal product	2. Pushing the employees to be highly competitive in their area of interest and building team with such mentality
3. Most world class companies have a predefined operational framework to tackle a new product launch	3. The best-in-class companies always try to enhance the existing framework & keep on modifying their structure to survive the competition

3.2 (Please answer only one question depending on your last digit on your UML ID)
For Patents, please provide an answer. Limit yourself to one paragraph, max 6 lines

2. How should you label any document during new project negotiations?

1. Always have a sales contract
2. Negotiate credit letter application
3. Should issue a letter of credit
4. Should have an advising letter of credit
5. control documents and release payment at maturity
6. Finally, a document release

5.1 (Please answer only one question depending on your last digit on your UML ID)

2. Compare the two scenarios for acquiring a machine for a project for 22 years expected operations, at a company with an internal rate of return of i = 15%. Which scenario is better? Please round to the nearest $.
Scenario 1. Buy an initial small machine at $12,000, it cost $2,400/year to run for the first 12 years, buy a second larger machine at $30,000 and run it for 10 years at a cost of $4,000/year. There is no salvage value at the end of service for either machine.
Scenario 2. Buy a large machine for $34,000 and run it for 22 years at a cost of $1,000/year. At the end of the 22 years, the machine is assumed to have a salvage value of $12,000.

Assumption:

- Machines are purchased at the beginning of the year
- Operational costs are added at the end of the year

Scenario 1	
ROI	15%
Initial Cost (small)	$12000
OC (small)	$2400/year
Initial Cost (large)	$30000
OC (large)	$4000/year
Salvage	None

Scenario 2	
ROI	15%
Initial Cost	$34000
OC	$1000/year
Salvage	$12000

(PV in dollars)	**Scenario 1**	**Scenario 2**
PV =	- Initial cost of smaller machine – Running cost of smaller machine (year 1 to 12) – initial cost of larger machine (at end of year 12) – Running cost of larger machine (from 11^{th} year till 22^{nd} year)	- Initial cost of large machine– Running cost of machine (till 22 years) + Salvage value after 22 years
PV =	-12000 - 2400(P/A, 15%,12) - 30000(P/F, 15%, 12) – [4000(P/A, 15%, 22) - 4000(P/A, 15%, 12)]	-34000 - 1000(P/A, 15%, 22) + 12000(P/F, 15%, 22)
PV =	-12000 - 2400*5.4206 – 30000*0.1869 – [4000*6.3587 – 4000*5.4206]	-34000 - 1000*6.3587 + 12000*0.0462
PV =	-$34368.84	-$39804.3

We can see that scenario 1 has lower PV magnitude and hence it is preferred to initially get small machine and then the larger one

5.2 (Answer only one question depending on your last digit UML ID), See note at Exam end

2. There are two electric motors that can provide 100 hp. Alpha motor can be purchased at $1,000 and has an efficiency of 85%, an estimated life of 10 years, and estimated maintenance costs of $50/year. Beta Motor will cost $1,400 and has an efficiency of 95%, life of 12 years and maintenance cost of $25/year. Assume that the company internal rate of return is 15%. Perform a Breakeven analysis to find out at what hours of operations the two motor costs are the same. Assume an electricity rate of $0.06 per kilowatt hour. Please plot your results.

For DETERMINING ELECTRIC MOTOR LOAD AND EFFICIENCY,
please use 100 hp = 100 Nameplate Rated Horsepower
page 3 equation 2,
https://www.energy.gov/sites/prod/files/2014/04/f15/10097517.pdf

P = 10hp = 100*(0.7457kWh) = 74.57 kWh
Electricity rate = $0.06/kWh
Internal rate of return = 15%
Let N be number of hours per year

	Alpha Motor	Beta Motor
Purchase Amount	$1000	$1400
Efficiency	85%	95%
Estimated Life	10 years	12 years
Estimated maintenance	$50/year	$25/year

	Alpha Motor	Beta Motor
Total Electricity cost =	1000(A/P, 15%, 10) + 50 + N*(74.57*0.06)/0.85	1400(A/P, 15%, 12) + 25*N + N*(74.57*0.06)/0.95
=	1000*(0.1993) + 50*1 + 5.26N	1400*(0.1845) + 25*1 + 4.71N
=	249.3 + 5.26N	283.3 + 4.71N

For Breakeven Point: 249.3 + 5.26N = 283.3 + 4.71N => N = 34/0.55 = 61.8 hours = 62 hours