MECH.5760 EPM Midterm Odd 7th Digit Exam. Name: **Kartik Patath (01983092)**

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 limit the amount of pages that you will submit

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

1-1 Chapter 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 = 0.8. Please determine the reject rate.

RR = 16400×10^{-6}

2 Sided } $C_p = \dfrac{USL - LSL}{6 * \text{Sigma}} = 0.8$

=) Process Sigma = $\pm\left(\dfrac{0.8 \times 6}{2}\right) * \text{Sigma}$

$= \pm\, 2.4$ Sigma Process. (rejection will be from both sides)

$\downarrow$

$Z = -2.4$

$\downarrow$

$f(Z) = 0.00820$

$= 8200 \times 10^{-6}$

∵ Rejection from both sides.

$2 \times f(Z) \rightarrow 16{,}400$ PPM

$\downarrow$

16400 defects in 1 million.

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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 8%. Please determine the Cp and Cpk of the pull test. (Assume average is centered = N)

Cp = 0.4667; Cpk = 0.4667

$RR = 8\%$
$= 0.08$

Since avg. is centered $\rightarrow C_p = C_{pk}$

Now,

$$Z = 3C_p = 3C_{pk}$$

$$RR = 0.08 = f(z) \text{ [one-sided]}$$

$$\Downarrow$$

$$Z \approx -1.4 \quad (f(z) = \underline{0.08}076)$$

$$\Rightarrow C_p = C_{pk} = \frac{1.4}{3} = 0.4667$$

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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

i) full-factorial

$\#$ Experiments $= 2^4 = 16$

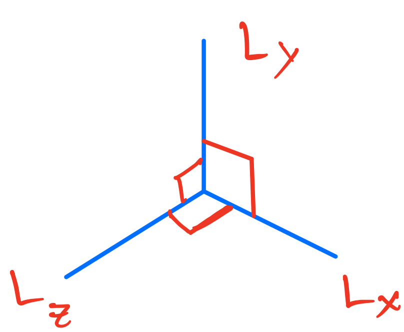
ii) half-factorial

$\#$ Experiments $= 2^{(4-1)} = 8$

iii) Saturated

$\#$ Experiments $= 8$ (Slide 7)

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



L_x, L_y & L_z are 3 mutually $\perp^{lar}$ axes.

which represent orthogonal design.

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Make sure that your answers in non-math problems are brief and to the point. Too many details will be graded negatively just as too little details. Please show background calculations for math problems.

Chapter 2. **(Please answer only one question depending on your last digit on your UML ID)**
2.1 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
i) A product is called maturity product when it is in the maturity stage of its cycle (i.e growth → Maturity → decline)	i) A Product is commodity when it is an input or a basic product in the production line. (i.e Products are infact made using commodities)
ii) Value to the Product can be added in the maturity stage.	ii) Value cannot be added to a commodity.
iii) A maturity Product is available in a Polished State.	iii) A commodity is always availiabe in a natural State.

2.2 (Please answer only one question depending on your last digit on your UML ID)
Briefly Discuss the attributes (max of three) 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

i) During this stage companies face a no. of different challenges & try to retain or establish their market share.

ii) It's a stage in which the Sales growth slows down after reaching a peak

iii) which also means that decreasing market share and declining Profits are often observed in this Stage.

iv) This stage usualy lasts longer than the growth stage/Startup stage.

v) This also a stage in which the Product competes against other Similar Products.

vi) Leading the company to increase advertisements & marketing of products.

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Chapter 3 Continued. **(Please answer only one question depending on your last digit on your UML ID)**

3.1 Briefly give **two (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. (Benchmarking).
i) These are the companies which provide the best possible Product, at the best possible Prize, when the customer needs it.	i) They thourougly Study the market of a Product & design their own version of a product which beats the existing competitors in the market.
ii) Driven to a single Vision & a shared goal among employees, which is to deliver the optimal Product.	ii) Pushing the employees to be highly competitive in their area of interest & building teams with such mentality.
iii) Most world class companies have a Predefined operational framework to tackle a new Product launch.	iii) The Best-in-class always tries to enhance the existing framework & keeps 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?

i) Always have a Sales contract.
ii) Negotiable credit letter application
iii) Should issue a letter of credit.
iv) Also, should have an advising letter of credit.
v) Documents control, Payment release at maturity.
vi) finaly a document release.

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Chapter 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 25 years expected operations, at a company with an internal rate of return of i = 14%. Which scenario is better? Please round to the nearest $.
Scenario 1. Buy an initial small machine at $12,000, it cost $2,400 to run for the first 12 years, buy a second larger machine at $30,000 and run it for 13 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 25 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.

Sol:- Assume → machines are purchased at the beginning of the year. (∴ at $n=0$ & $n=12$)
→ Operation cost is assumed to be incorporated at the end of a year.

Now,

Smaller machine → Operation cost is assumed to be incorporated at the end of a year (i.e end of 1^{st} yr ($n=1$) uptill end of 12^{th} yr ($n=12$))

Larger machine → operates from ($n=13$ to $n=25$)

Scenario 1 :-

ROI → 14%

IC_{small} → \$18,000

IC_{Large} → \$25,000

OC_{small} → \$2400/yr (1 to 12)

OC_{large} → \$4000/yr

No salvage.

PV = initial cost of smaller machine (year 0) − Running cost of smaller machine (year 1 to 12)

− initial cost of larger machine (yr 12 end) − Running cost of next 8 yrs (Starting from 13th year and 25th year end)

$$\Rightarrow PV = -\$18,000 - 2,400(P/A, 14\%, 12) - 25,000(P/F, 14\%, 12) - [4000 \times (P/A, 14\%, 25) - 4000 \times (P/A, 14\%, 12)]$$

$$= -\$18,000 - 2,400 \times (5.6603) - 25,000 \times (0.2076) - [4000 \times (6.8729) - 4000 \times (5.6603)]$$

$$= -41,625.12\$$$

Senario 2 :-

ROI → 14%

IC → \$ 34,000

OC → \$ 1000/yr (n=1 to 20)

salvage → \$ 12,000

PV = initial cost of large machine (year 0) – Running cost of machine (years 1 to 25) + Salvage value after 22 yrs.

$$\Rightarrow PV = -\$34{,}000 - 1000\,(P/A, 14\%, 25) + 6000\,(P/F, 14\%, 25)$$

$$= -\$34{,}000 - 1000\,(6.8729) + 6000\,(0.0378)$$

$$= -40{,}646.1\ \$$$

We can see that Senario 2 has lower PV & hence it is prefered to get 1 large machine and run it for 25 yrs.

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

Chapter 5.2 (Please answer only one question depending on your last digit on your UML ID)

2. There are two electric motors that can provide 100 hp. Alpha motor can be purchased at $1,400 and has an efficiency of 50%, an estimated life of 10 years, and estimated maintenance costs of $50/year. Beta Motor will cost $1,800 and has an efficiency of 60%, life of 12 years and maintenance cost of $25/year. Assume that the company internal rate of return is 12%. 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.

sol

$P = 100hp = 100 \times (0.7457 \text{ kWh}) = 74.57 \text{ kWh}$

	α	β
Purchased	\$1400	\$1800
efficiency	50%	60%
estimated life	10 yrs	12 yrs
estimated maintenance	\$50/yr	\$25/yr

electricity rate → \$0.06 | Annual return rate → 12%

α - motor :-

Total electricity cost $= 1400(A/P, 12\%, 10) + 50 + [(74.57 \times 0.06)/0.5] \times N$

$= 1400(0.177) + 50 + 8.9484N$

$TE = 297.8 + 8.948N \rightarrow (1)$

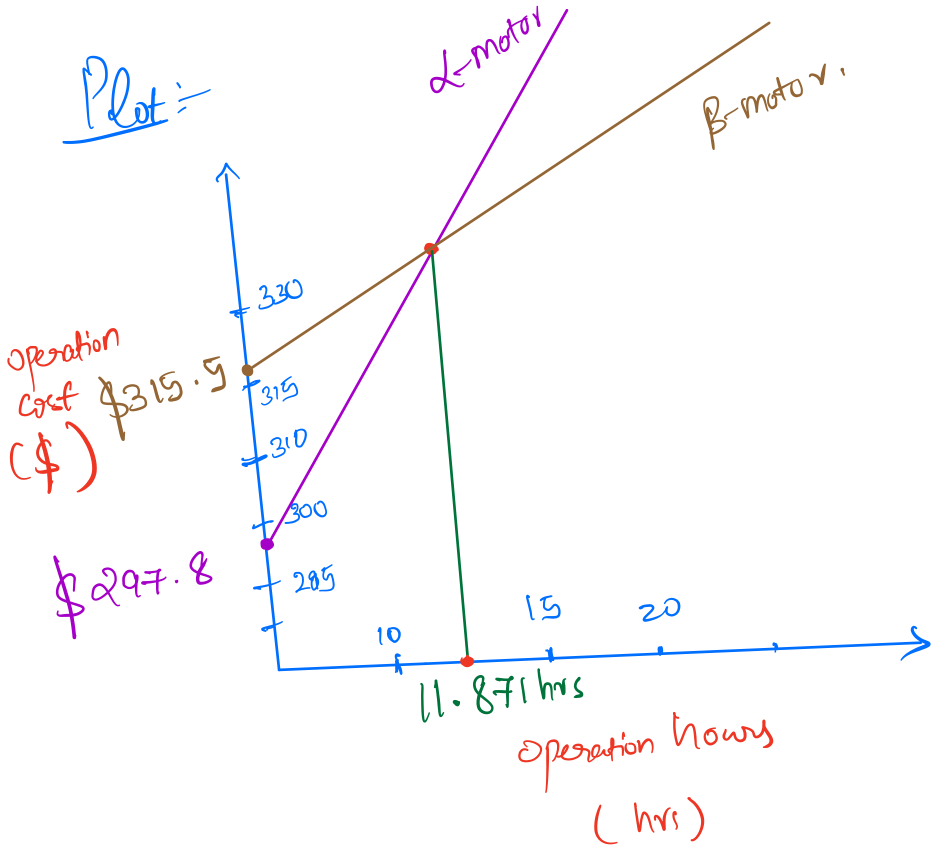
β - motor :-

Total electricity cost $= 1800(A/P, 12\%, 12) + 25 + [(74.57 \times 0.06)/0.6] \times N$

$= 1800(0.1614) + 25 + 7.457N$

$TE = 315.5 + 7.457N \rightarrow (2)$

Plot :-



Conclusion :-

at $N = 11.871$ hrs we reach a breakeven.