STA305/1004: Exam Jam Review Session Problems

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Problem 1

An engineer is intrested in the effects of cutting speed (A), tool geometry (B), and cutting angle (C) on the life of a machine tool. Two levels of each factor are chosen and all factor-level combinations were run three times.

(a) What type of design did the engineer use?
(b) Which effects are statistically significant at the 5% level?
(c) Estimate the factorial effect of cutting angle? What is it's standard error?
(d) Interpret the main effect of cutting angle.
(e) Would using a half-normal plot be useful in determining which effects are significant?
(f) Suppose that the engineer wanted to study an additional factor using the same 2^3 factorial design. Suggest a design where the engineer would have the ability to estimate all the main effects and two-factor interactions. What is the design matrix of this design?

R Output for problem 1

```
mod1 <- lm(Life.Hours~Cutting.Speed*Tool.Geometry*Cutting.Angle,data=prob1)
round(summary(mod1)$coefficients,2)
```

```
                                          Estimate Std. Error t value
(Intercept)                                  40.83       1.12   36.42
Cutting.Speed                                 0.17       1.12    0.15
Tool.Geometry                                 5.67       1.12    5.05
Cutting.Angle                                 3.42       1.12    3.05
Cutting.Speed:Tool.Geometry                  -0.83       1.12   -0.74
Cutting.Speed:Cutting.Angle                  -4.42       1.12   -3.94
Tool.Geometry:Cutting.Angle                  -1.42       1.12   -1.26
Cutting.Speed:Tool.Geometry:Cutting.Angle    -1.08       1.12   -0.97
                                          Pr(>|t|)
(Intercept)                                   0.00
Cutting.Speed                                 0.88
Tool.Geometry                                 0.00
Cutting.Angle                                 0.01
Cutting.Speed:Tool.Geometry                   0.47
Cutting.Speed:Cutting.Angle                   0.00
Tool.Geometry:Cutting.Angle                   0.22
Cutting.Speed:Tool.Geometry:Cutting.Angle     0.35
```

Problem 1 Interaction plot
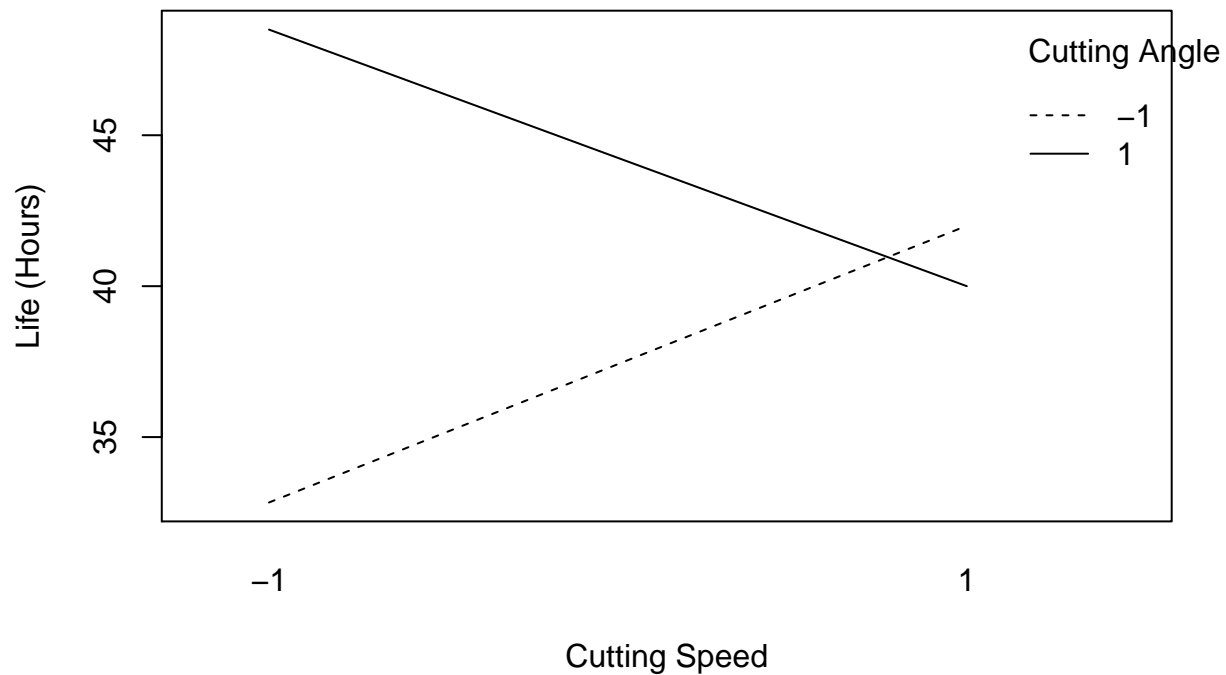
Problem 2

To compare the effects of five different assembly methods (A, B, C, D, E) on the throghput (the number of completed pieces per day), an experiment was conducted involving three blocking variables: day, operator, and machine type. Five operators were tested over five days on five machine types. Each pair of assembly method and machine type is tested on one day by one operator (i.e. once in the experiment). What is the name of this experimental design? Explain your reasoning.

Problem 3

The following are weights (in grams) of six rock samples (randomly collected from different lakes) measured on two different scales (I, II). The purpose of this data collection is to test whether the two scales are different.

Scale	1	2	3	4	5	6
I	8	14	16	19	18	12
II	11	16	20	18	20	15

What type of statistical design was used in this experiment? What statistical test could be used to test whether the two scales are different?