NAME: Solutions

Math 124 FALL 2004: Section 6 TTh 8:10-9:25 AM
Midterm 2 **Date: Apr 28, 2005**

Instructions: Answer questions 1-4. There is a bonus question, but you can get a perfect score without attempting it. Show as much work as you feel reasonable. You have 75 minutes. To allow others to fully concentrate at the end please do not leave in the last 5 minutes. You should submit your page of notes with your test paper.

Question 1. (*25 points*)

Define each of the following and explain why or how it is used (in the context of an experiment)

(a.) *Randomization*

5pts

a procedure for assigning subjects/units/individuals to treatments in a non systematic way. We could use a computer to generate random numbers to do the assigning. It is used to reduce bias

(b.) *Confounding*

5pts

Two variables are confounded when their effects on a response variable can not be distinguished from each other. May be explanatory or lurking variables.

(c.) *Block* and *Block Design*

5pts

A block is a group of experimental units or subjects known to be similar in some way that is expected to affect the response variable. Block designs have treatments randomly assigned within blocks.

Blocking is done to reduce variation.

(d.) *Single-blind* and *Double-blind*

5pts

Single blind - means the recepient (ie patient) does not know whether they receive the drug or a placebo
Double blind - means that neither the experimenter (eg physician) or the patient know whether they receive the treatment or placebo. For avoiding bias

(e.) *Replication*

5pts

repeating the experiment at the same treatment setting many times. It is done to reduce chance variation.

Question 2. (*25 points*)

An factory manager is interested in the bond strength of a new adhesive product which is being considered for routine use on a production line. The adhesive is used to join together two plastic parts, of which there are unlimited supplies. The adhesive supplier has provided 27 equal sized samples of the adhesive. In the factory the machine which performs the gluing has three different temperature settings (280F, 300F and 320F) and three different pressure settings(100, 150 and 200 psi). A machine which measures the breaking strength is available for use.

(a.) Identify the factors, their levels, the treatments and a response variable for this experiment.

Factors - Temperature Settings, Pressure

Levels: 280F, 300F, 320F; 100psi, 150psi, 200psi

12pts

treatments:
280F - 100psi
280F - 150psi
280F - 200psi
300F - 100psi
300F - 150psi
300F - 200psi
320F - 100psi
320F - 150psi
320F - 200psi

Response - breaking strength

(b.) Describe and outline an appropriate design for this experiment.

Randomly assign the 27 glue samples into 9 groups

13pts

Temp \ Pressure	100 psi	150 psi	200 psi
280F	3glues	3glues	3glues
300F	3glues	3glues	3glues
320F	3glues	3glues	3glues

For fearther randomization, randomly chose order in which the treatments are applied. After glue has set measure force needed to break bond.

Question 3. (*25 points*)

The life time of a particular brand of automobile tire is known to be normally distributed with mean 35000 miles and standard deviation 5250 miles. Suppose the manufacturer offers a warranty that guarantees free replacement if a tire does not last at least 20000 miles.

(a.) What is the probability that a tire lasts between 27500 and 40000 miles?

Let $X \equiv$ "Lifetime of a tire" X is distributed $N(35000, 5250)$

$$P(27500 < X < 42000) = P\left(\frac{27500 - 35000}{5250} < \frac{X - 35000}{5250} < \frac{42000 - 35000}{5250}\right)$$

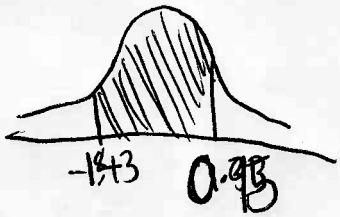
$$= P(-1.43 < Z < 0.95)$$

$$= P(Z < 0.95) - P(Z < -1.43)$$

$$= .8289 - .0764$$

$$= .7525$$

9pts



(b.) What is the probability that a tire will not need warranty replacement?

"won't need warranty replacement" $\equiv X > 20000$

$$P(X>20000) = P\left(\frac{X-35000}{5250} > \frac{20000-35000}{5250}\right)$$

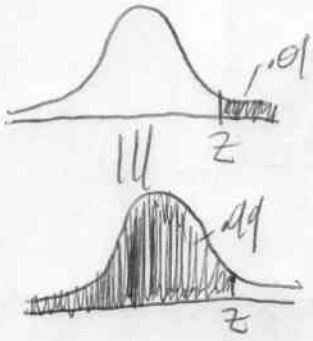
$$= P(Z > -2.86)$$

$$= 1 - P(Z < -2.86)$$

$$= 1 - .0021 = .9979$$

8pts

(c.) Above how many miles will the top 1% of tires of this brand last?



Want x for which $P(X>x) = .01$

Looking in table for .99 closest entry

vs .9901 which corresponds to $z = 2.33$

So $x = \sigma z + \mu$

$= (5250)(2.33) + 35000$

$= 47232.5$ miles

8pts

Question 4. (*25 points*)

The number of flaws per square meter of carpet material varies with mean 1.8 and standard deviation 1.0 flaws per square meter. An inspector studies 150 square meters of carpeting, selected at random from a particular run of carpet, records the number of flaws per square meter and then calculates $\bar{x}$ which is the sample mean number of flaws found per square meter of carpet. Suppose that if the mean number of flaws per square meter is above 2 then the run of carpet will have be sold at a discounted price.

(a.) What is the standard deviation of the sample mean?

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}} = \frac{1}{\sqrt{150}} = 0.0816 \text{ (4dp)}$$

8pts

(b.) What is the distribution of the sample mean?

7pts

because $n=150$ is large by CLT

$\bar{X}$ is approx $N(1.8, 0.0816)$

(c.) Calculate the probability that a run of carpet will have to be discounted.

"Discounted" $\equiv \bar{X} > 2.05$

10pts

$$P(\bar{X} > 2.00) \approx P\left(\frac{\bar{X} - 1.8}{.0816} > \frac{2.00 - 1.8}{.0816}\right)$$

$$= P(Z > 2.45)$$

$$= 1 - P(Z < 2.45)$$

$$= 1 - .9929$$

$$= .0071$$