

1. A experiment was conducted to compare the effectiveness of three fungicides (A, B, and C) at protecting corn seed from fungus damage. The three fungicides and a control treatment (D) were randomly assigned to 20 batches of corn seed so that there are 5 batches for each of the four treatments (A, B, C, and D). Each batch of treated seeds was planted in its own plot. The number of plants reaching maturity was recorded for each plot. Some SAS code and output is provided below.

```
proc glm;
  class trt;
  model count=trt;
  means trt;
  means trt / dunnett('D');
run;
```

Dependent Variable: count

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	97.2000000	32.4000000	4.11	0.0243
Error	16	126.0000000	7.8750000		
Corrected Total	19	223.2000000			

Level of trt	N	Mean	Std Dev
A	5	27.0000000	2.34520788
B	5	24.0000000	2.00000000
C	5	27.6000000	2.07364414
D	5	22.2000000	4.20713679

Dunnett's t Tests for count

Alpha	0.05
Minimum Significant Difference	4.6011

trt Comparison	Difference Between Means	Simultaneous 95% Confidence Limits	
C - D	5.400	0.799 10.001	***
A - D	4.800	0.199 9.401	***
B - D	1.800	-2.801 6.401	

Hsu's Comparison with Best

Level	Best	Mean Diff	Lower Limit	Upper Limit	p Value
Alpha = 5% DF=16 Root MSE=2.8062 d=2.2271					
A	C	-0.6	-4.5527	3.3527	0.6155
B	C	-3.6	-7.5527	0.3527	0.0715
D	C	-5.4	-9.3527	0	0.0102

- (a) Are there any significant differences among the four treatment means? Give a test statistic, p-value, and a decision at the 0.05 level of significance.
 - (b) Estimate the difference between the average of the fungicide means (A, B, and C) and the control mean (D).
 - (c) Compute the standard error of the contrast estimated in part (b).
 - (d) Determine a 95% confidence interval for the contrast estimated in part (b).
 - (e) Name the fungicide means that are significantly different from the control mean at experimentwise significance level 0.05.
 - (f) Provide a list of treatments that contains the best treatment with 95% confidence.
 - (g) Briefly summarize the conclusions that you have reached through the analysis of this data.
2. An experiment was conducted to investigate the relationship between driving speed and gasoline consumption for a particular make and model of automobile. One car was driven for 10 miles at constant speed around a track in 12 separate trials. Below are data on the amount of gas consumed (in hundredths of gallons) and the speed driven (in miles per hour) for each of the 12 trials. Some SAS code and parts of the output appear below the data table.

Trial	1	2	3	4	5	6	7	8	9	10	11	12
Speed in miles/hour	30	30	35	35	40	40	45	45	50	50	55	55
Gas Used in 0.01 Gallons	45	50	36	32	27	26	24	27	29	27	37	33

```

data a;
  input speed gasused;
  x=speed;
  cards;
<<<<DATA HERE>>>>

proc glm;
  class speed;
  model gasused=x x*x x*x*x x*x*x*x x*x*x*x*x speed;
run;

```

Dependent Variable: gasused

Source	DF	Sum of Squares	Mean Square
Model	??	???????	???????????
Error	??	35.50	???????????
Corrected Total	??	712.25	

Source	DF	Type I SS
x	1	189.78
x*x	1	483.48
x*x*x	1	3.03
x*x*x*x	1	0.02
x*x*x*x*x	1	0.44
speed	0	0.00

- (a) Give the degrees of freedom missing from the SAS output.
 - (b) Give the sum of squares missing from the SAS output.
 - (c) Give the mean squares missing from the SAS output.
 - (d) Can the relationship between driving speed and gas consumption be described adequately by a polynomial equation? Conduct all the tests needed to answer this question. For each test, give a test statistic and the relevant table value. If the data can be described adequately by a polynomial equation, state the necessary degree (linear, quadratic, cubic, or quartic).
3. The remaining questions are all related to the design of the experiment described in question 2. The random digits below will be needed to answer some of the questions.

84713 28178 24640 83428 90058 28704 27140 29724 08366 24986 79213 48688
40551 63943 07844 09940 94745 88628 57677 14562 13713 13925 52520 82215

- (a) The data table makes it appear as if the speed was systematically increased by 5 miles per hour every second trial. It would have been more appropriate to randomly assign the 6 speeds to the 12 trials. Use the first row of the random digits above to obtain a random assignment of the 6 speeds to the 12 trials.
- (b) Name the response variable for the experiment.
- (c) Name each of the treatments in the experiment.
- (d) What are the experimental units?
- (e) What are the observational units?
- (f) How many replications are there for each treatment?
- (g) The experiment was conducted with a single car. Name one advantage and one disadvantage of this strategy.
- (h) Suppose two cars (A and B) had been available for use in the study. Use the second row of random digits to develop a good design for an experiment that uses two cars (A and B) and 12 trials to examine the relationship between gas consumption and the 6 speeds used previously. Name the car and the speed that is to be used in each of the 12 trials. Explain how you used the random number table if your strategy will not be clear from your written work.