Indian Statistical Institute, Bangalore

M.S. (QMS) First Year

Second Semester - Statistics For Decision Making-II

Final Exam Time: 3 hours Date: 25/04/2016 Maximum Marks: 50

This paper has 60 Marks. Answer as many questions as you can, but the maximum score is limited to 50.

1. For the One Way ANOVA, consider the model $y_{ij} = \mu + \alpha_i + \varepsilon_{ij}$,
(for all i=1,2,....,a & j=1,2,.....,n),
Where μ = Overall Population mean,
α_i = Effect of the ith class (i=1,2,.....,a) and
ε_{ij} = Error for the jth observation in the ith class(j=1,2,.....,n), and
ε_{ij}'s (for each i=1,2,....,a & j=1,2,.....,n) are independently normally distributed with zero mean and constant variance = σ^2.
Show that Mean square error (MSE) is an unbiased estimator of σ^2. [10]

2. The life in hours of a battery is known to be approximately normally distributed, with [3 + 3 + 4 = 10]
standard deviation σ =1.25 hours. A random sample of 10 batteries has a mean life of xbar= 40 hours.
   (a) Is there evidence to support the claim that battery life exceeds 40 hours? Use $\alpha = 0.05$.
   (b) What is the *P*-value for the test in part (a)?
   (c) What is the β-error for the test in part (a) if the true mean life is 42 hours?

3. A taxi company manager is trying to decide whether the use of radial tires instead of regular belted tires improves fuel economy. Twelve cars were equipped with radial tires and driven over a prescribed test course. Without changing drivers, the same cars were then equipped with regular belted tires and driven once again over the test course. The gasoline consumption, in kilometres per litre, was recorded as follows:

Kilometres per Litre

Car	Radial Tires	Belted Tires
1	4.2	4.1
2	4.7	4.9
3	6.6	6.2
4	7.0	6.9
5	6.7	6.8
6	4.5	4.4
7	5.7	5.7
8	6.0	5.8
9	7.4	6.9
10	4.9	4.7
11	6.1	6.0
12	5.2	4.9

Can we conclude that cars equipped with radial tires give better fuel economy than those equipped with belted tires?
Assume the populations to be normally distributed. [8]

4. In an experiment to study the dependence of hypertension on smoking habits, the following data were taken on 180 individuals:

	Non-smokers	**Moderate Smokers**	**Heavy Smokers**
Hypertension	21	36	30
No hypertension	48	26	19

Test the hypothesis that the presence or absence of hypertension is independent of smoking habits. Use α =0.05.. [7]

5. A study was made by a retail merchant to determine the relation between weekly advertising expenditures and sales. [10 + 3 = 13]

Advertising Costs (Rs. In hundreds)	**Sales (Rs. In hundreds)**
40	385
20	400
25	395
20	365
30	475
50	440
40	490
20	420
50	560
40	525
25	480
50	510

a) Find the equation of the regression line to predict weekly sales from advertising expenditures.
b) Estimate the weekly sales when advertising costs are 35 (Rs. in hundreds)

6. An electrical engineer is investigating a plasma etching process used in semiconductor manufacturing. It is of interest to study the effects of two factors, the C2F6 gas flow rate (A) and the power applied to the cathode (B). The response is the etch rate. Each factor is run at 3 levels, and 2 experimental runs on etch rate are made for each of the 9 combinations. The data are given below [12]

	Power Supplied		
C2F6 Flow Rate	**1**	**2**	**3**
1	288	488	670
	360	465	720
2	385	482	692
	411	521	724
3	488	595	761
	462	612	801

Analyze the data using ANOVA and draw conclusions.