THE OPEN UNIVERSITY OF SRI LANKA
B.Sc./B.Ed. Degree Programme, Continuing Education Programme
APPLIED MATHEMATICS – LEVEL 04
PSU 2182/PSE 4182 – DESIGN AND ANALYSIS OF EXPERIMENTS
OPEN BOOK TEST 2009/2010

Duration: One and Half Hours.

Date: 29.03.2010	**Time: 11.30 a.m.- 1.00 p.m.**

Answer all questions.

(1) 'Effectiveness' of four brands of washing powder (A, B, C, and D) in the market are to be compared. Following resources are available to conduct an experiment to meet this objective.

- Forty (40) pieces of equally dirty cloths of the same size (made out of the same material)
- 100g of washing powder from each brand
- Any amount of water
- A person who is ready to conduct the experiment

Following procedure is proposed to conduct the experiment. Five grams of washing powder is dissolved in two liters of water and a piece of dirty cloth is soaked in it for 15 minutes. Then the cloth will be washed and the 'cleanness' of the piece of cloth is measured using an optical instrument. Cleanness is considered to be the effectiveness of the washing powder.

(i) Identify the treatments of this experiment.

(ii) Identify the response variable of the experiment.

(iii) State whether the treatment structure is simple or factorial. Justify your answer.

(iv) What kind of design structure (i.e. CRD, RCBD, LSD, etc.) is suitable to conduct this experiment? Justify your answer.

(v) How do you apply the concept of randomization in conducting this experiment?

(2) A doctor is interested in testing the effectiveness of three pain killers used after a particular operation. The pain killer is given just after the operation and the time taken to relieve the pain will be measured. The effectiveness of the pain killer is higher if the time taken to relieve the pain is less and vise-versa. Six patients who are getting ready to this operation have given their written consent to take part in the experiment to meet the objective stated above. Out of these 6 patients 3 of them are males and the rest of them are females. All of them are in the same age group (50-55 years) and have similar health conditions. It is known that the time taken to relieve the pain depends on the gender of the person. However, the effect of the pain killer does not depend on the gender of the person.

(i) What is the design structure to be used in this experiment? Justify your answer.

(ii) Clearly explain how you would instruct the doctor in conducting this experiment.

(3) It is required to identify the best Nitrogen-N, Phosphorus-P and Potassium-K combination to be used in the fertilized mixture for the growth of a particular plant. Two levels of each Factor of N, P, and K (i.e. N1 and N2, P1 and P2, K1 and K2) are to be considered in the experiment. Twenty four plants grown under similar condition are available for the experiment. They are 2 weeks old and they are very much similar in size, shape, etc. Fertilizer mixture is to be applied when they are 4 weeks of age. Heights of the plants are measured 6 weeks after applying the fertilizer.

(i) Identify the treatments to be applied.

(ii) How many replications are possible for each treatment?

(iii) What are the sources of variation of this experiment?

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Answer Guide

1. (i) Treatments are the four brads of washing powder (A, B, C and D).
(ii) Response variable is 'Cleanness' of the piece of cloth.
(iii) This is a Simple treatment structure.
In here it is considered only about one factor (Brand of washing powder). Treatments are the levels of a single factor. Not a level combination of several factors.
(iv) Completely Randomized Design (CRD) is suitable for this experiment.
In a CRD structure, all experimental units are assumed homogeneous and the treatments are assigned to the experimental units completely at random. In this experiment it is used 40 pieces of equally dirty cloths of the same size made out of the same material. So it can be assumed that all experimental units are homogeneous. Four treatments (A, B, C, and D) can be assigned to 40 experimental units in a completely random manner.
(v) This is an experiment with 4 treatments and 40 experimental units. That means 10 replicates for each treatment. The 40 runs should me made in random order. Suppose that we number the runs as follows.

Washing Powder	Experiment run number
A	01 02 03 04 05 06 07 08 09 10
B	11 12 13 14 15 16 17 18 19 20
C	21 22 23 24 25 26 27 28 29 30
D	31 32 33 34 35 36 37 38 39 40

Now select a random number between 1 and 40. Suppose we get 13. Then the 13^{th} observation with Washing powder type B is run first. This process would be repeated until all 40 have been assigned a position in the test sequence.

2. (i) Design structure is Randomize Complete Block Design (RCBD).
Gender of the patients can be considered as a blocking factor, and it is known that the time taken to relieve the pain depends on the gender of the person & effect of the pain killer does not depend on the gender of the person.
(ii) The study involves pain killer with 3 types and gender with 2 types. Since there are 2 blocks (Male & Female) each pain killer can randomly assigned to one person in each block. We assign three treatments to three people (male or female) in a completely random manner.

3. (i) $T_1 = N_1P_1K_1$ $T_2 = N_1P_1K_2$ $T_3 = N_1P_2K_1$ $T_4 = N_1P_2K_2$
$T_5 = N_2P_1K_1$ $T_6 = N_2P_1K_2$ $T_7 = N_2P_2K_1$ $T_8 = N_2P_2K_2$
(ii) We have 8 treatments and have 24 plants. Hence there are 3 replicates for each treatment combination.
(iii)

Source Of, Variation
N
P
K
NP
NK
PK
NPK
Error