



November, 2008

Unit: 76 – Management Mathematics

This paper is not to be removed from the Examination Halls

Student Name :

Student Number :

**TIME ALLOWED : 3 hours**

Candidates should answer all of the **FIVE** questions. All questions carry equal marks.

Candidates are strongly advised to divide their time accordingly.

Graph paper is provided at the student request.

A hand held non-programmable calculator **may be used** when answering questions on this paper. The make and type of machine used must be stated clearly on the front cover of the answer book.

**PLEASE TURN OVER**

Answer **ALL** of the following **Five** questions:

1. An insurance company insures 20 000 businesses against the perils of fire, flood and storm damage. During a ten year period 99% of these businesses make no claim at all against the insurance company. No business claims for more than one of the perils at a time but of those businesses that have made one or more claims during the stated ten year period time:
- 40% have claimed for fire damage.
  - 50% have claimed for flood damage.
  - 38% have claimed for storm damage.
  - 10% have claimed on different occasions for fire and storm damages.
  - 15% have claimed on different occasions for flood and storm damages.
  - 5% have claimed on different occasions for fire and flood damages.

a) If **X** is the number of businesses making claims for all the three perils, calculate the number of businesses (as a function of **X**) in each of the eight disjoint subsets which can be logically identified and produce an appropriate Venn diagram for percentage of businesses making claims. **(8 Marks)**

b) How many businesses have claimed for all three types of damages (fire, flood and storm) on separate occasions? **(6 Marks)**

c) Assuming no business has claimed for the same type of damage more than once, how many claims in total have been made? **(6 Marks)**

2. Suppose the consumption this year is the average of last years consumption and this year's income, that is :

$$C_t = \frac{1}{2} (Y_t + C_{t-1})$$

Suppose also that the relationship between next year's income and current investment is  $Y_{t+1} = k I_t$  for some positive constant  $k$ .

- a.) Assuming the equilibrium condition :  $Y_t = C_t + I_t$  holds, show that  $Y_t$  satisfies the following second order difference equation:

$$Y_t - \left(\frac{k+1}{2}\right)Y_{t-1} + \frac{k}{2}Y_{t-2} = 0 \quad \textbf{(6 Marks)}$$

- b.) Suppose  $k = 3$  and that the initial value  $Y_0$  is positive. Solve the equation:

$$Y_t - 2Y_{t-1} + \frac{3}{2}Y_{t-2} = 0 \quad \textbf{(6 Marks)}$$

Show that  $Y_t$  oscillates with increasing magnitude. **(3 Marks)**

- c.) Discuss according to the values of  $k$  the behaviour of  $Y_t$  the solution of the equation given in (a). **(5 Marks)**

3. Eight employees (A,B,C...H) of a company give answers (Y=Yes,N=No) to six different questions about themselves. The results are as follows:

Question	Employee							
	A	B	C	D	E	F	G	H
Do you have a Management degree?	Y	Y	N	N	N	Y	N	N
Are you older than 40?	N	Y	N	N	Y	Y	N	N
Are you male?	Y	Y	Y	Y	N	Y	N	N
Did you join our company in the last 2 years?	Y	N	N	N	N	Y	N	N
Are you married?	N	Y	N	N	N	Y	N	N
Have you worked abroad?	N	Y	N	N	N	Y	Y	Y

The company wants to use this data in order to form 3 groups of employees who are as similar as possible within a group but as different as possible between the groups.

- (a) Construct a similarity matrix for the employees. **(4 marks)**
- (b) Using a single linkage hierarchical clustering approach, determine the constituent employees of the three groups and produce a suitable diagram to show the clustering process. **(12 marks)**
- (c) It is planned to repeat the above type of process in other divisions of the company. However it is felt that some of the questions are asking similar types of question to each other. Suggest two questions you might consider dropping from the questionnaire, and explain your reasoning. **(4 marks)**
4. (a) Explain the difference of Single Linkage and Complete Linkage in cluster analysis. Under what circumstances would you use one of these techniques in preference to the other? **(6 Marks)**

- (b) Consider the distances between pairs of five objects as follows:

$$D = (d_{ij}) = \begin{matrix} & \begin{matrix} 1 & 2 & 3 & 4 & 5 \end{matrix} \\ \begin{matrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{matrix} & \begin{bmatrix} - & & & & \\ 9 & - & & & \\ 3 & 7 & - & & \\ 6 & 5 & 9 & - & \\ 11 & 10 & 2 & 8 & - \end{bmatrix} \end{matrix}$$

Produce a Dendrogram of clustering these objects using single and complete linkages hierarchical technique.

**(14 Marks)**

- 5 (a). In multivariate data analysis what is a 'multiple scatter plot' and what are its uses? **(5 marks)**
- (b) What is meant by the term 'outlier' and why are 'outliers' important? **(3 marks)**
- (c) The following table shows bivariate observations on 21 subjects:

Subject	Value of X	Value of Y
1	1	1
2	2	2
3	2.5	1.5
4	2.5	3.5
5	3	2
6	3	3
7	3	3.5
8	3.5	2
9	3.5	2.5
10	4	3
11	4	3.5
12	4.5	2.5
13	5	4
14	5	5
15	5.5	5.5
16	6	3.5
17	6	4
18	6.5	1
19	6.5	5
20	7	11
21	11.5	6

You are asked to:

- i. Draw A Box and Whisker diagram ('Box Plot') for each variable to identify any 'outliers' or 'extremes'. **(8 marks)**
- ii. Produce a scatter diagram of X against Y and clearly mark the observation(s) that you have identified as possible 'outliers' or 'extremes'. Do any other subjects seem to produce 'outlying' results? **(4 marks)**

**END OF PAPER**