MANAGEMENT STUDIES TRIPOS
DIPLOMA IN MANAGEMENT STUDIES

Tuesday 2 May 2000 1.30 to 4.30

Paper M2

QUANTITATIVE METHODS AND OPERATIONS MANAGEMENT

*Answer not more than **four** questions, **two** from Section **A** and **two** from Section **B**.*

All questions carry the same number of marks.

Answers to questions in each section should be tied together and handed in separately.

*The **approximate** number of marks allocated to each part of a question is indicated in the right margin.*

SECTION A

1 (a) Describe briefly the steps involved in statistical hypothesis testing. [20]

(b) The Table below shows data obtained from a survey on the preferred modes of transport of people who both live and work in Cambridge. Respondents were asked to indicate the attractiveness of travelling to work by car and by bus, on a scale of 1 to 5 (where 1 means highly unattractive and 5 means highly attractive).

Frequencies

	Attractiveness of bus					
Attractiveness of car	no reply	1	2	3	4	5
no reply	0	2	1	0	1	0
1	2	14	13	7	4	2
2	2	12	11	6	5	3
3	1	5	5	2	1	1
4	0	2	2	1	1	0
5	0	0	0	0	0	0

Treating the level of the data as ordinal, test the null hypothesis that, within the population concerned, there is no difference in the attractiveness of car compared with bus against the alternative hypothesis that there is a difference. Use a significance level of 5%. [25]

(c) Explain in principle how you would alter your calculation in (b) if none of the formulae on the formulae sheet nor any statistical tables were available to you. (You are not expected to carry out the actual calculation in detail.) [30]

(d) A colleague notes that 28 respondents were indifferent between the two modes of transport, and suggests that their responses must have some bearing on the test carried out in (b). How would you respond? [25]

2 A new shopping centre is being proposed for Cambridge, involving substantial modifications to the area currently occupied by the Robert Sayle Department Store and the Lion Yard multi-storey car park. The City Council wishes to obtain the views of shoppers who would be affected and is considering carrying out a survey of their opinions. The Council knows what issues it wishes to ask shoppers about but seeks advice on how to carry out the survey. Write a report outlining the kinds of issues you think the Council will need to consider, the decisions it will need to make, and how (as far as possible) it could go about making these decision. [100]

3 (a) Write brief notes on the basic principles of the design of tables when conveying quantitative data for demonstration purposes. [60]

(b) Describe, with justifications, the changes you would make if you had the opportunity to redo the survey carried out in the MS2 Course. The broad topic of the survey should remain the same. You may wish to consider changes to the questionnaire, the way that the survey was carried out, or different hypotheses that you would wish to test. [40]

4 (a) Explain briefly the differences between *parametric* and *non-parametric* statistical hypothesis tests.

(b) The data in the Table below were collected as part of a survey in which a sample of men and a sample of women were asked how many people they purchase Christmas presents for:

Number of People	Men	Women
0	0	0
1	0	1
2	1	0
3	1	0
4	1	5
5	4	3
6	3	2
7	2	2
8	2	0
9	1	1
10	0	1
11 or more	0	0

Test the null hypothesis that men and women buy presents for the same number of people on average against the alternative hypothesis that they buy presents for different numbers of people, using:

(i) a parametric test;

(ii) a non-parametric test.

(You may find the following data useful: the means and standard deviations of the number of people for whom presents are bought are 5.73 and 1.91 respectively for men, and 5.4 and 2.23 respectively for women. The standard deviations are based on the formula with $(n-1)$ rather than (n).) [50]

(c) How would you decide which of the two tests in (b) is more appropriate in this situation? [25]

SECTION B

5 Ulrich's Luxury Jaffa Cake Shop has recently opened in Cambridge city centre. The shop is run by Mr Karl Ulrich, and is open 7 days a week throughout the year. Ulrich's sells Luxury Jaffa Cakes, and by agreement with the supplier (LJC Ltd. Of Glasgow), Ulrich's is the only shop in Cambridgeshire that is permitted to sell Luxury Jaffa Cakes. However, the jaffa cakes constitute only small portion of the sales volume of Ulrich's business. Many customers are attracted by the novelty of a shop that carries this item and, after walking through the door, may or may not purchase Luxury Jaffa Cakes, but usually purchase other items that are available there as well.

The Luxury Jaffa Cakes are produced and packaged in tins in Scotland and each tin contains 24 cakes. Ulrich has found demand for tins of Luxury Jaffa Cakes to be reasonably level at 175 per month. He must pay LJC Ltd. £1.85 per tin and there is also a delivery fee of £150, regardless of the order size. Ulrich estimates that his other costs are as follows: annual cost of capital, 20 per cent; the combined costs of shelf space, insurance and taxes, 7 per cent of the value of the item per annum; cost of placing an order with LJC Ltd., £50, which comprises his time, telephone charges and other miscellaneous costs. Ulrich must plan carefully, as it takes exactly three weeks for him to receive the shipment once he places the order with LJC Ltd.

(a) How often should Ulrich place an order with LJC Ltd.? [20]

(b) How many tins should Ulrich have in stock when he rings up LJC Ltd. to place an order?

(c) Ulrich is wondering whether these Luxury Jaffa Cakes, which he has been selling for three pounds per tin, exclusive of VAT, are in fact profitable. To the nearest pound, what is Ulrich's annual profit from sales of Luxury Jaffa Cakes? [30]

(d) Imagine that Ulrich's Luxury Jaffa Cake Shop has been in operation for a year now, and has been making a substantial profit. However, for marketing reasons, LJC LTd. has just begun stamping the tins of cakes with a sell-by date, and this date is always 4 weeks from the date that the tins arrive at Ulrich's shop in Cambridge. In the light of this development, what should Mr Ulrich's decision be with respect to ordering Luxury Jaffa Cakes? Explain your answer. [30]

6 The assembly operation at Midsummer Television Assembly (MTA) operates on a six-hour workday and assembles a single product, a High Definition Television (HDTV) called the Granta, for sale in the European Union (EU). Assembly of the Granta consists of eleven operations, whose processing times (in seconds) and immediate predecessors (I.P.) are listed in the following table:

Operation	1	2	3	4	5	6	7	8	9	10	11
Time	4	38	45	12	10	8	12	10	2	10	34
I.P.	none	none	none	1,2	2	4	5	6	7	8,9	3,10

(a) Company policy has been to operate under the *minimum feasibly cycle time*. Under this constraint, determine the minimum number of workstations required for the assembly process. Using this balance, how many Grantas per day will be assembled? [20]

(b) The MTA Management now wants the assembly to be determined by the *ranked positional weights heuristic* using a 45-second cycle time. Determine the balance resulting from this heuristic. You should specify the operations and the idle time at each station. [20]

(c) The European Commission has now ruled that, in order to be permitted to continue selling Granta HDTVs in the EU, MTA must adhere to the following directive. The commission will group each operation at MTA into one of three 'labour modules' as shown in the table below. At each workstation, all operations must come from a single labour module.

	Labour Module 1	Labour Module 2	Labour Module 3
Operations	1,2,3,4,6	5,7,8,9	10,11

Under the assumption that assembly continues to be based on a 45 second cycle time, determine the optimal balance under the European Commission rule. [30]

(d) Assume now that the European Commission rule does not apply, and that the MTA management has decided against the use of heuristics and wants you to consider only optimal solutions. What is the minimum cycle time that would result in a four-station balance? [30]

7 Archer Industries of Grantchester produces Millennium coins which are highly likely to be very valuable in fifty years' time. The company president has hired you as a consultant to verify that demand forecasts (which are used in the promotional literature for the coins) are being arrived at in a proper manner. Monthly demand for the coins during 1999 was as follows:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
89	57	144	221	177	280	223	286	212	275	188	312

The company president has instructed you to use the arithmetic average of the data from January to June inclusive to initialise an exponential smoothing process, and then to determine the one-month-ahead exponentially smoothed forecasts for August, September, November and December. You are about to suggest a value of alpha (the smoothing constant), but the company president instructs you to choose alpha so that this procedure will yield a one-month-ahead forecast in November for December of 209.2.

(a) To two decimal places, what value of alpha should you use to satisfy the company president? Note that you are *not* expected to solve a polynomial equation (involving powers of alpha) to find the answer. [30]

(b) Use a six-method moving average to obtain forecasts for August to December. Then use the MAD to compare the accuracy of the forecasts you obtained via exponential smoothing with the forecasts you obtained with the moving average to determine which method is 'superior', that is, provides the more accurate forecast. [30]

(c) Give a brief explanation of why the method you found to be superior was more accurate than the alternative method.

8 You have been hired to be the Operations Manager for a manufacturing firm called AMF Ltd. Several months prior to your arrival, AMF had hired a consultancy to learn how to improve its operations. A copy of the consultancy report is placed on your desk the day you arrive, and your first assignment is to interpret it for your boss. After reading the report thoroughly, you see that the key recommendation is for AMF to increase the length of production run on its main manufacturing line. You check with your boss, who tells you that AMF did indeed follow the recommendation of the consultancy, which resulted in fewer manufacturing set-ups per month. Consequently, two production supervisors were able to take on additional productive tasks in the time that made available in the reduction in set-up times. You go back to your office, and open up the report and start examining closely the technical appendix. You then realise that the consultancy, having anticipated an increase in the production supervisors' idle time, had not included the additional benefit of this to the company in the calculations on which they based their recommendations.

(a) Provide a concise explanation for your boss of the error that you think the consultants have made. [20]

(b) Your boss asks what will happen to the length of the production runs if the error is corrected. How would you respond? [20]

(c) Your boss now gives you a new problem. It seems that AMF is planning to open up a manufacturing line for a new product. This product requires a basic component, called the BC2000, with an anticipated yearly demand of 2500 units. The BC2000 can either be purchased from an outside vendor at £25 each, or it can be manufactured 'in-house' at the rate of 10 000 units per year at £22 each. If the BC2000 is purchased from the vendor, the ordering cost is £5 per order, whilst if it is manufactured, the setup cost will be £50 per run. The inventory holding cost of the BC2000 is 10% of the cost of the item. Should the BC2000 be purchased from the outside vendor or should we manufacture it in-house? Justify your answer. [30]

(d) What other factors not mentioned above could realistically affect your decision as to whether to purchase from an outside vendor or manufacture in house? [30]

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