MANAGEMENT STUDIES TRIPOS
DIPLOMA IN MANAGEMENT STUDIES

Tuesday 1 May 2001   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) Explain the difference in the data requirements of the Wilcoxon-Mann-Whitney Test and the Wilcoxon Signed Ranks Test [20]

(b) The Table below shows data obtained from the 2000/1 MST/Diploma Survey of final year undergraduate students. The data showed the expected starting salaries for the first job after graduation for eleven students from one particular college.

Final year undergraduates	£
Gender	Expected Starting Salary
M	29000
M	15000
M	20000
F	15000
M	20000
F	32000
F	20000
M	19500
M	20000
F	18000
F	22000

Source:2000/1 MST/Diploma Survey

Using a non-parametric test, test the null hypothesis that, within the population concerned, there is no difference in the salary expectations of men and women against the alternative hypothesis that there is a difference. Use a significance level of 5%

[40]

(c) Explain how you interpret the phrase *the population concerned* in (b)

[15]

(d) Explain why the statistical tables required for the Wilcoxon Signed Ranks Test do not need to indicate which of the two rank-sums one chooses to call T^+ and which one chooses to call T^-, whereas for the Wilcoxon-Mann-Whitney Test. W_x is always defined as the rank-sum for one of the two groups (conventionally the *smaller* group). [25]

2   Write brief notes on:

     (a)   Tufte's *Lie Factor* and *Data-ink ratio;*   [30]

     (b)   The issues involved in selecting a random sample of final year
Undergraduate students to interview in a college of the University   [35]

     (c)   the wording of questions in a questionnaire   [35]

3   (a)   Explain briefly what is meant by the terms *simple random sampling*,
quota sampling, *cluster sampling*, and *the design effect*.   [25]

     (b)   A company wishes to estimate the total number of televisions in the

50,000 houses in Cambridge. National data suggest that the number of televisions per house follows a Normal distribution with a standard deviation of 1.2. The company is considering using a quota sample, which would have an expected design effect of 2.0. Find an equation for the sample size which ensures that (with 90% probability) the estimate of the total number of televisions is within $\pm E$ of the correct total. Hence , or otherwise, find the sample size necessary to achieve $E = 10,000$ and $E = 1000$.

     [30]

     (c)   Do you think the sample size necessary to estimate the average number of televisions per house would differ between the USA and the UK? Explain your answer.   [25]

     (d)   Discuss the extent to which the error in the sample in (b) can be said to be zero if the sample size is equal to the whole population.   [20]

4   (a)   Describe briefly when you might use a Kolmogorov-Smirnov one sample test.   [15]

(b)   The table below shows data obtained from the 2000/1 MST/Diploma Survey of final year undergraduate students. The data show the number of hours per week students expect to work in their first job after graduation.

Final year undergraduates	*frequencies*
Hours per week	Number of Respondents
0-29	6
30-39	86
40-49	101
50-59	34
60-99	20

Source: 2000/1 MST/Diploma Survey

The mean and standard deviation of the hours per week were 47.2 and 10.1 respectively.

Using a Kolmogorov-Smirnov test, test the null hypothesis that the number of hours per week that final year undergraduate students expect to work follows a Normal distribution against the alternative hypothesis that it does not. You may ignore the continuity correction factor in your calculations. Use a significance leve1 of 5%.

[35]

(c)   Test the null and alternative hypotheses in (b) using a χ^2 test rather than a Kolmogorov-Smirnov test.   [35]

(d)   Which of the test in (b) and (c) do you feel is more appropriate in this situation? Explain your answer.   [15]

SECTION B

5   (a)   In simple exponential smoothing, much depends on the choice of the smoothing constant α. Compare the use of a large value of α with the use of a small value of α.   [25]

(b)   If there exists an upward, or downward, trend in the data, how will simple exponential smoothing and a moving average respond to it?   [25]

(c)   Name one significant advantage of simple exponential smoothing over the moving average. Name one significant advantage of the moving average over simple exponential smoothing.   [25]

(e)   Recall that the formula for exponential smoothing is:

$$S_t = \alpha \, x_t + \alpha \, (1 - \alpha) \, x_{t-1} + \alpha \, (1 - \alpha)^2 \, x_{t-2} + \alpha \, (1 - \alpha)^3 \, x_{t-3} + \ldots$$

By replacing t with $(t+1)$ in this equation, generate the updating formula that expresses S_{t+1} in terms of S_t.   [25]

6   (a)   Define in general terms what the term *bottleneck* means in an operations management context, and explain its significance with respect to the output of an organisation.   [40]

(b)   In a manufacturing environment, what rule must be established with regard to the work at the bottleneck?

(c)   In a manufacturing environment, describe two negative effects of a non-bottleneck operation running faster than the bottleneck, and analyse why these occur.   [30]

(d)   In a manufacturing setting, choking the release of non-bottleneck machines, in order that they run at the full capacity speed of the bottleneck, can have several beneficial effects. List two of these effects and identify issues that might be faced in achieving them.   [20]

7   You have taken a new job running the production department for a marketing firm in Manchester that finds that it is most economical to produce 360 00 units annually. The facility produces in fixed batch sizes of 6000 (using the EOQ with production), and the annual storage cost is £15 per unit. The firm works on the basis of a 30 day month.

(a)   If each production run costs £75 to set up, what is the daily production rate of the plant?   [60]

(b)   The accounting department has informed you that next year the holding cost and ordering cost will increase by the same percentage, somewhere between5 and 8 percent. At this point, they cannot be more specific. Based on this information, what can you say about the effect this cost increase will have on the optimal batch size?   [20]

(c)   Suppose that this year, instead of producing the units in-house, the firm had ordered them from an outside vendor. Assuming that the vendor has the same ordering and storage costs, and that there are no additional costs for placing the order with the vendor, how would you expect the size of orders placed with the vendor would compare with the size of production runs produced in-house?   State any additional assumptions that you require.   [20]

8   (a)   Explain briefly what is meant by the term *crash cost*. Give an example of crash cost that could occur in the healthcare sector.   [20]

(b)   Consider the project delineated in the Table below.   In addition to the costs shown, there are indirect costs of £100 per day.

Activity	Immediate Predecessors	Normal Time (weeks)	Normal Cost (£)	Crash Time (weeks)	Crash Cost (£)
a	none	32	200	26	500
b	none	21	300	20	375
c	none	30	200	30	200
d	a	45	500	40	800
e	a,b	26	700	20	1360
f	c	28	1000	24	1160
g	e,f	20	400	18	550

Determine the optimal time in days to complete the project.   [60]

(c)   Determine the optimal completion cost for the project in (b).   [20]

END OF PAPER