NEWCASTLE UNIVERSITY

SCHOOL OF MATHEMATICS & STATISTICS

SEMESTER 2 2006/07

MAS1403

Quantitative Methods for Business Management

Time allowed: 2 hours

Credit will be given for all answers to questions in Section A, and for the best TWO answers to questions in Section B.

No credit will be given for other answers and students are strongly advised not to spend time producing answers for which they will receive no credit.

Marks for each question are indicated. However you are advised that marks indicate the relative weight of individual questions, they do not correspond directly to marks on the University scale.

There are FIVE questions in Section A and FOUR questions in Section B.

Graph paper will be provided. Statistical tables are provided on the final pages of this exam paper. This is an "open book" examination. Lecture notes, text books etc. may be consulted during the examination.

Write your solutions to Section A in the spaces provided on this exam paper, and your solutions to Section B in a separate answer book. Place this exam paper inside the answer book at the end of the exam.

Student number: ..... ***Degree code:*** .....

SECTION A

A1. The following data are total monthly sales (April 2007, in thousands of pounds) for an Italian Pizza chain in ten cities in England:

17 23 28 31 33 35 38 42 42 55

(a) Calculate the mean, median and standard deviation for these pizza sales.

.....

(b) Construct a stem–and–leaf plot for these data.

Stem unit = ***Leaf unit =***

.....

[**9 marks**]

A2. A small airline company knows that 10% of its customers require a special in–flight meal (i.e. vegetarian/gluten–free etc.). There are twenty people booked on tomorrow's flight between Newcastle and Barcelona.

(a) What probability distribution might be reasonable to use to model the number of people requiring a special in–flight meal on tomorrow's flight?

. . . . . .

(b) Find the expected number of people requiring a special in–flight meal.

. . . . . .

(c) Find the probability that, on tomorrow's flight, exactly three customers will require a special in–flight meal.

. . . . . .

(d) The flight time from Newcastle to Barcelona is Normally distributed with mean 132 minutes and standard deviation 10 minutes. Find the probability that tomorrow's flight will take less than two hours.

. . . . . .

[12 marks]

A3. A South American wine importer sells litre bottles of wine to restaurants in the north–east. A random sample of twenty four bottles gave an average volume of 985ml with a standard deviation of 5ml.

(a) Construct a 95% confidence interval for the average volume of a bottle of wine from this importer.

. . . . . .

(b) Do the restaurants using this importer have cause for concern? Explain your answer.

. . . . . .

[**8 marks**]

A4. The average weekly wages of English and Australian students working as part–time bar–staff are to be compared. A random sample of fifty English students and forty Australian students who work part–time in a bar gave the following results (in £):

	English	Australian
Mean	118.20	109.45
Standard deviation	25.50	30.30

Perform an appropriate hypothesis test to determine whether there is a difference between the average income of English and Australian students. *[Hint: The pooled standard deviation is £27.73]*

. . . . . .

[9 marks]

A5. OzTour are a specialist sightseeing tour company based in Far North Queensland. The results of a customer satisfaction survey for their crocodile tour, for males and females, are shown below for a random sample of 300 customers who toured with them between January and March this year.

	Male	Female	**Total**
Unsatisfactory	19	32	51
Satisfactory	64	75	139
Excellent	88	22	110
Total	171	129	300

(a) State your null and alternative hypotheses to test for an association between gender and level of satisfaction.

. . . . . .

(b) Calculate your test statistic.

. . . . . .

Question A5 continued on next page

(c) Obtain a range for your p–value, and form your conclusions.

. . . . . .

[12 marks]

SECTION B

B6. Consider the following data for daily sales at a large retail outlet before, and after, a celebrity–endorsed collection was introduced.

Sales (X thousand £)	Before	After
$2 \leq x < 4$	2	0
$4 \leq x < 6$	6	1
$6 \leq x < 8$	9	4
$8 \leq x < 10$	12	10
$10 \leq x < 12$	18	15
$12 \leq x < 14$	13	18
$14 \leq x < 16$	8	20
$16 \leq x < 18$	7	10
$18 \leq x < 20$	1	3
Total	76	81

(a) Use the frequency table above to estimate mean sales before and after the collection was introduced.

(b) Construct frequency polygons for sales before and after the introduction of the celebrity–endorsed collection, and overlay these polygons on the same graph. Comment.

(c) Using the frequency table above, find the probability that sales lie between £14,000 and £16,000, after the collection was introduced.

(d) The standard deviation for sales after the collection was introduced can be estimated from the above table as £1250. Assuming sales follow a Normal distribution with a mean as calculated in part (a), find the probability that sales after the collection was introduced lie between £14,000 and £16,000.

(e) Compare your answers to parts (c) and (d), suggesting a reason for any differences.

[25 marks]

B7. The manager of a small I.T. sales company has the opportunity to buy a fixed quantity of a new type of soundcard for home PCs which they can then offer for sale to clients.

The decision to buy the product and offer it for sale would involve a fixed cost of £200,000. The number of soundcards that would be sold is uncertain, but the manager's prior beliefs are expressed as follows.

- Sales will be "poor" with probability 0.2; this will result in an income of £100,000.
- Sales will be "moderate" with probability 0.5; this will result in an income of £220,000.
- Sales will be "good" with probability 0.3; this will result in an income of £350,000.

For an additional fixed cost of £30,000, market research can be conducted to aid the decision–making process. The outcome of the market research can be either positive or negative, with probabilities 0.58 and 0.42 respectively. Knowing the outcome of the market research changes the probabilities for the main sales project as follows:

	Main sales probabilities		
Market research	Poor	Moderate	Good
Positive	0.15	0.45	0.4
Negative	0.6	0.35	0.05

The manager will make decisions based on expected monetary value.

(a) Draw a decision tree for this problem.

(b) Use expected monetary value to determine the optimal course of action for the company.

[25 marks]

B8. Spice Boyz are a small company producing gingerbread men. A batch of standard gingerbread men uses 40kg of flour and 4kg of sugar, whereas a batch of deluxe gingerbread men requires 20kg of flour and 10kg of sugar. The company has at most 240kg of flour and 40kg of sugar available each day.

Spice Boyz makes a profit of £3 on a batch of standard gingerbread men and £7 on a batch of deluxe gingerbread men. The company makes and sells x batches of standard gingerbread men and y batches of deluxe gingerbread men.

(a) Formulate the company's situation as a linear programming problem.

(b) Draw a suitable diagram to enable the problem to be solved graphically, indicating the feasible region and the direction of the objective line.

(c) Use your diagram to find the company's maximum profit, £P.

[25 marks]

B9. A local department store, "Get–It–All", are considering a takeover bid for one of their rival stores. To see if a bid is worthwhile, "Get–It–All" study the three–monthly sales figures for their rival over the last three years. These are shown below, in tens of thousands of pounds.

	Jan–Apr	May–Aug	Sep–Dec
2004	16	8	25
2005	20	12	29
2006	22	14	32

(a) Produce a time series plot for these data, and comment.

(b) Calculate the moving averages for these data, and overlay these on your plot in part (a).

(c) Let T represent time, and let time–points $i = 1, 2, \ldots,$ correspond to Jan–Apr (2004), May–Aug (2004), ... (respectively). Also, let Y be the moving averages calculated in part (b). Then we have the following summaries:

$$\sum_{i=2}^{8} t = 35 \qquad \sum_{i=2}^{8} y = 138.67$$

$$\sum_{i=2}^{8} t^2 = 203 \qquad \sum_{i=2}^{8} ty = 722.33$$

Use the summaries above to estimate the linear trend

$$Y \;=\; \alpha + \beta T + \epsilon.$$

(d) The (unadjusted) seasonal effects are given in the table below.

"Season"	Seasonal effects
Jan–Apr	+1.905
May–Aug	–7.206
Sep–Dec	+8.905

Obtain the *adjusted* seasonal effects.

(e) Use the linear trend equation in part (c), and the adjusted seasonal effects in part (d), to forecast sales for the current four–month period (i.e. May–Aug 2007).

[25 marks]

THE END

Statistical tables

		p				
	One–tailed test	10%	5%	2.5%	1%	0.5%
	Two–tailed test	20%	10%	5%	2%	1%
	1	3.078	6.314	12.706	31.821	63.657
	2	1.886	2.920	4.303	6.965	9.925
	3	1.638	2.353	3.182	4.541	5.841
	4	1.533	2.132	2.776	3.747	4.604
	5	1.476	2.015	2.571	3.365	4.032
	6	1.440	1.943	2.447	3.143	3.707
	7	1.415	1.895	2.365	2.998	3.449
	8	1.397	1.860	2.306	2.896	3.355
	9	1.383	1.833	2.262	2.821	3.250
	10	1.372	1.812	2.228	2.764	3.169
	11	1.363	1.796	2.201	2.718	3.106
	12	1.356	1.782	2.179	2.681	3.055
	13	1.350	1.771	2.160	2.650	3.012
	14	1.345	1.761	2.145	2.624	2.977
ν	15	1.341	1.753	2.131	2.602	2.947
	16	1.337	1.746	2.120	2.583	2.921
	17	1.333	1.740	2.110	2.567	2.898
	18	1.330	1.734	2.101	2.552	2.878
	19	1.328	1.729	2.093	2.539	2.861
	20	1.325	1.725	2.086	2.528	2.845
	21	1.323	1.721	2.080	2.518	2.831
	22	1.321	1.717	2.074	2.508	2.819
	23	1.319	1.714	2.069	2.500	2.807
	24	1.318	1.711	2.064	2.492	2.797
	25	1.316	1.708	2.060	2.485	2.787
	26	1.315	1.706	2.056	2.479	2.779
	27	1.314	1.703	2.052	2.473	2.771
	28	1.313	1.701	2.048	2.467	2.763
	29	1.311	1.699	2.045	2.462	2.756
	⋮	⋮	⋮	⋮	⋮	⋮
	∞	1.282	1.645	1.960	2.326	2.576

Table 1: This table contains values of t for which $\Pr(T > t) = p$, where $T \sim t_\nu$. In a two–tailed test, the tabulated values correspond to $\Pr(|T| > t) = p$

	p				
	50%	10%	5%	1%	0.1%
1	0.45	2.17	3.84	6.63	10.83
2	1.39	4.61	5.99	9.21	13.82
3	2.37	6.25	7.82	11.34	16.27
4	3.36	7.78	9.49	13.28	18.47
5	4.34	9.24	11.07	15.09	20.52
6	5.35	10.64	12.59	16.81	22.46
7	6.35	12.02	14.07	18.48	24.32
ν 8	7.34	13.36	15.51	20.09	26.13
9	8.34	14.68	16.92	21.67	27.88
10	9.34	15.99	18.31	23.21	29.59
12	11.34	18.55	21.03	26.22	32.91
15	14.34	22.31	25.00	30.58	37.70
20	19.34	28.41	31.41	37.57	45.32
25	24.34	34.38	37.65	44.31	52.62
30	29.34	40.26	43.77	50.89	59.70

Table 2: This table contains values of x for which $\Pr(X^2 > x) = p$, where $X^2 \sim \chi^2_\nu$

z	-0.09	-0.08	-0.07	-0.06	-0.05	-0.04	-0.03	-0.02	-0.01	0.00
-2.9	0.0014	0.0014	0.0015	0.0015	0.0016	0.0016	0.0017	0.0018	0.0018	0.0019
-2.8	0.0019	0.0020	0.0021	0.0021	0.0022	0.0023	0.0023	0.0024	0.0025	0.0026
-2.7	0.0026	0.0027	0.0028	0.0029	0.0030	0.0031	0.0032	0.0033	0.0034	0.0035
-2.6	0.0036	0.0037	0.0038	0.0039	0.0040	0.0041	0.0043	0.0044	0.0045	0.0047
-2.5	0.0048	0.0049	0.0051	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062
-2.4	0.0064	0.0066	0.0068	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082
-2.3	0.0084	0.0087	0.0089	0.0091	0.0094	0.0096	0.0099	0.0102	0.0104	0.0107
-2.2	0.0110	0.0113	0.0116	0.0119	0.0122	0.0125	0.0129	0.0132	0.0136	0.0139
-2.1	0.0143	0.0146	0.0150	0.0154	0.0158	0.0162	0.0166	0.0170	0.0174	0.0179
-2.0	0.0183	0.0188	0.0192	0.0197	0.0202	0.0207	0.0212	0.0217	0.0222	0.0228
-1.9	0.0233	0.0239	0.0244	0.0250	0.0256	0.0262	0.0268	0.0274	0.0281	0.0287
-1.8	0.0294	0.0301	0.0307	0.0314	0.0322	0.0329	0.0336	0.0344	0.0351	0.0359
-1.7	0.0367	0.0375	0.0384	0.0392	0.0401	0.0409	0.0418	0.0427	0.0436	0.0446
-1.6	0.0455	0.0465	0.0475	0.0485	0.0495	0.0505	0.0516	0.0526	0.0537	0.0548
-1.5	0.0559	0.0571	0.0582	0.0594	0.0606	0.0618	0.0630	0.0643	0.0655	0.0668
-1.4	0.0681	0.0694	0.0708	0.0721	0.0735	0.0749	0.0764	0.0778	0.0793	0.0808
-1.3	0.0823	0.0838	0.0853	0.0869	0.0885	0.0901	0.0918	0.0934	0.0951	0.0968
-1.2	0.0985	0.1003	0.1020	0.1038	0.1056	0.1075	0.1093	0.1112	0.1131	0.1151
-1.1	0.1170	0.1190	0.1210	0.1230	0.1251	0.1271	0.1292	0.1314	0.1335	0.1357
-1.0	0.1379	0.1401	0.1423	0.1446	0.1469	0.1492	0.1515	0.1539	0.1562	0.1587
-0.9	0.1611	0.1635	0.1660	0.1685	0.1711	0.1736	0.1762	0.1788	0.1814	0.1841
-0.8	0.1867	0.1894	0.1922	0.1949	0.1977	0.2005	0.2033	0.2061	0.2090	0.2119
-0.7	0.2148	0.2177	0.2206	0.2236	0.2266	0.2296	0.2327	0.2358	0.2389	0.2420
-0.6	0.2451	0.2483	0.2514	0.2546	0.2578	0.2611	0.2643	0.2676	0.2709	0.2743
-0.5	0.2776	0.2810	0.2843	0.2877	0.2912	0.2946	0.2981	0.3015	0.3050	0.3085
-0.4	0.3121	0.3156	0.3192	0.3228	0.3264	0.3300	0.3336	0.3372	0.3409	0.3446
-0.3	0.3483	0.3520	0.3557	0.3594	0.3632	0.3669	0.3707	0.3745	0.3783	0.3821
-0.2	0.3859	0.3897	0.3936	0.3974	0.4013	0.4052	0.4090	0.4129	0.4168	0.4207
-0.1	0.4247	0.4286	0.4325	0.4364	0.4404	0.4443	0.4483	0.4522	0.4562	0.4602
0.0	0.4641	0.4681	0.4721	0.4761	0.4801	0.4840	0.4880	0.4920	0.4960	0.5000

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
0.0	0.5000	0.5040	0.5080	0.5120	0.5160	0.5199	0.5239	0.5279	0.5319	0.5359
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596	0.5636	0.5675	0.5714	0.5753
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987	0.6026	0.6064	0.6103	0.6141
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368	0.6406	0.6443	0.6480	0.6517
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736	0.6772	0.6808	0.6844	0.6879
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088	0.7123	0.7157	0.7190	0.7224
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422	0.7454	0.7486	0.7517	0.7549
0.7	0.7580	0.7611	0.7642	0.7673	0.7704	0.7734	0.7764	0.7794	0.7823	0.7852
0.8	0.7881	0.7910	0.7939	0.7967	0.7995	0.8023	0.8051	0.8078	0.8106	0.8133
0.9	0.8159	0.8186	0.8212	0.8238	0.8264	0.8289	0.8315	0.8340	0.8365	0.8389
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531	0.8554	0.8577	0.8599	0.8621
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749	0.8770	0.8790	0.8810	0.8830
1.2	0.8849	0.8869	0.8888	0.8907	0.8925	0.8944	0.8962	0.8980	0.8997	0.9015
1.3	0.9032	0.9049	0.9066	0.9082	0.9099	0.9115	0.9131	0.9147	0.9162	0.9177
1.4	0.9192	0.9207	0.9222	0.9236	0.9251	0.9265	0.9279	0.9292	0.9306	0.9319
1.5	0.9332	0.9345	0.9357	0.9370	0.9382	0.9394	0.9406	0.9418	0.9429	0.9441
1.6	0.9452	0.9463	0.9474	0.9484	0.9495	0.9505	0.9515	0.9525	0.9535	0.9545
1.7	0.9554	0.9564	0.9573	0.9582	0.9591	0.9599	0.9608	0.9616	0.9625	0.9633
1.8	0.9641	0.9649	0.9656	0.9664	0.9671	0.9678	0.9686	0.9693	0.9699	0.9706
1.9	0.9713	0.9719	0.9726	0.9732	0.9738	0.9744	0.9750	0.9756	0.9761	0.9767
2.0	0.9772	0.9778	0.9783	0.9788	0.9793	0.9798	0.9803	0.9808	0.9812	0.9817
2.1	0.9821	0.9826	0.9830	0.9834	0.9838	0.9842	0.9846	0.9850	0.9854	0.9857
2.2	0.9861	0.9864	0.9868	0.9871	0.9875	0.9878	0.9881	0.9884	0.9887	0.9890
2.3	0.9893	0.9896	0.9898	0.9901	0.9904	0.9906	0.9909	0.9911	0.9913	0.9916
2.4	0.9918	0.9920	0.9922	0.9925	0.9927	0.9929	0.9931	0.9932	0.9934	0.9936
2.5	0.9938	0.9940	0.9941	0.9943	0.9945	0.9946	0.9948	0.9949	0.9951	0.9952
2.6	0.9953	0.9955	0.9956	0.9957	0.9959	0.9960	0.9961	0.9962	0.9963	0.9964
2.7	0.9965	0.9966	0.9967	0.9968	0.9969	0.9970	0.9971	0.9972	0.9973	0.9974
2.8	0.9974	0.9975	0.9976	0.9977	0.9977	0.9978	0.9979	0.9979	0.9980	0.9981
2.9	0.9981	0.9982	0.9982	0.9983	0.9984	0.9984	0.9985	0.9985	0.9986	0.9986

Table 3: This table contains values of $\Pr(Z < z)$, where $Z \sim N(0, 1)$

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