THE UNIVERSITY OF MELBOURNE

Student ID _____

Semester / Year: xxx

Faculty / Dept: Management and Marketing

Subject Code: MGMT90141

Subject Name: Business Analysis and Decision Making

Writing Time: 2 hrs

Reading Time: 15 minutes

Open Book Status: No

Number of Pages (including this page): 10

Authorised Materials: Calculator – Casio FX82 (any suffix)

Instructions to Students:
This examination contributes 50% to the final subject mark.
Use two decimal points for calculations when relevant.
Write down your stream onto the front page of the answer booklet(s), e.g., Tuesday 2.15pm, etc.

This examination paper includes 2 sections.

Section 1: Contains 1 compulsory question. You are required to answer this question. This section accounts for 25 marks.

Section 2: Contains 4 selective questions. You are required to answer 3 questions. This section accounts for 75 marks.

Instructions to Invigilators:
Student may keep the paper: No
Student may annotate the paper during reading time: Yes
Paper to be held by Library: No

Extra Materials Required (please supply):
Graph paper: No Multiple Choice form: No

SECTION 1 (compulsory)

Question 1

Personal Mini Warehouses is planning to expand its successful Melbourne business into Sydney. The company must determine the best possible combination of large space and small space storage rooms to build to reach the maximum monthly earnings. Each large space storage room costs $2 to advertise and requires 100 square foot. Each small space storage room costs $4 to advertise and requires 50 square foot. The advertising budget available is $400, and the area available is 8,000 square foot. The number of large space storage rooms must not exceed 60. The monthly earning of each large space storage room is $50, and that of each small space storage room is $20.

The sensitivity analysis report is shown as below.

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B10	Storage rooms Large	60	0	50	1E+30	10
C10	Storage rooms Small	40	0	20	5	20

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
B16	Advertising budget available LHS	?	0	400	1E+30	120
B17	Square footage required LHS	?	0.4	8000	1500	2000
B18	Rental limit expected LHS	60	10	60	20	20

(i) Formulate the linear programming (LP) model for the Personal Mini Warehouses.

(7 marks)

(ii) For the optimal solution, how much of the advertising budget is spent?

(3 marks)

(iii) For the optimal solution, how much square footage will be used?

(3 marks)

(iv) Would the solution change if the budget were only $300 instead of 400?

(4 marks)

(v) What would the optimal solution be if the profit on the large spaces were reduced from $50 to $45?

(4 marks)

(vi) How much would earnings increase if the square footage requirement were increased from 8,000 to 9,000?

(4 marks)

SECTION 2 (answer three out of four questions)

Question 2

(i) Eddie Kelly is running for reelection as mayor of a small town in Victoria. Jessica Martinez, Kelly's campaign manager during this election, is planning the marketing campaign, and there is some stiff competition. Martinez has selected four ways to advertise: television ads, radio ads, billboards, and newspaper ads. The costs of these, the audience reached by each type of ad, and the maximum number of each is shown in the following table. In addition, Martinez has decided that there should be at least six ads on TV, and at least six ads on radio. The amount spent on billboards and newspaper together must not exceed the amount spent on TV ads. While fundraising is still continuing, the monthly budget for advertising has been set at $15,000.

Types of ad	Cost per ad	Audience reached per ad	Maximum number
TV	$800	30,000	10
Radio	$400	22,000	10
Billboards	$500	24,000	10
Newspaper	$100	8,000	10

Formulate the LP model to determine the number of ads of each type to be placed such that the total number of people reached is maximized.

(10 marks)

(ii) The East Coast company's long-range planning group developed forecasts of the anticipated annual demand at the distribution centers as:

Distribution center	Annual demand
Detroit	12,000
Toledo	8,000
Houston	10,000
Miami	8,000
St. Louis	6,000

Because of an anticipated increase in demand, the company plans to increase capacity by constructing a new warehouse in one or more of the following cities: Atlanta, Boston, Chicago, or Denver. The estimated annual fixed cost and the annual capacity for the four proposed warehouses are as follows:

Proposed warehouse	Annual fixed cost	Annual capacity
Atlanta	$30,000	28,000
Boston	$25,000	26,000
Chicago	$20,000	24,000
Denver	$15,000	22,000

The shipping cost per unit from each warehouse to each distribution center:

	Distribution center				
Warehouse	Detroit	Toledo	Houston	Miami	St. Louis
Atlanta	3	4	4	5	2
Boston	6	5	6	15	8
Chicago	7	4	10	6	7
Denver	6	6	7	8	9

Formulate the LP model to determine which warehouse(s) should the company operate AND how many products should be shipped from warehouse *i* to distribution center *j* to reach the minimum total costs.

(15 marks)

Question 3

(i) Prentice Hall, Inc., a publisher headquartered in London, wants to assign three recently hired college graduates, Adam, Brian, and Carlos to regional sales districts in Birmingham, Manchester, and Liverpool. But the firm also has an opening in Newcastle and would send one of the three there if it were more economical than a move to Birmingham, Manchester, or Liverpool. It will cost $1,000 to relocate Adam to Newcastle, $800 to relocate Brian there, and $1,500 to move Carlos. Formulate the LP model to determine the optimal assignment of personnel to offices.

	Office		
Personnel	Birmingham	Manchester	Liverpool
Adam	$800	$1,100	$1,200
Brian	$500	$1,600	$1,300
Carlos	$500	$1,000	$2,300

(8 marks)

(ii) The distribution system for the Herman Company consists of three plants, two warehouses, and four customers. Plant capacities and shipping costs per unit (in dollars) from each plant to each warehouse are as follows:

	Warehouse		
Plant	1	2	Capacity
1	4	7	400
2	8	5	600
3	5	6	300

Customer demand and shipping costs per unit (in dollars) from each warehouse to each customer are:

	Customer			
Warehouse	1	2	3	4
1	6	4	8	4
2	3	6	7	7
Demand	300	300	300	400

~~Construct a transportation table for the transshipment problem.~~ Then, formulate the LP model for the problem. (Hints: use P1, P2, and P3 to denote the plants, use W4 and W5 to denote the warehouses, and use C6, C7, C8, and C9 to denote the customers.)

(17 marks)

Question 4

Blake Electronics Corporation is considering the introduction of a new product. The company can use one of the two designs for this product. Design A will be more profitable if consumer preferences remain basically unchanged. Design B will be more profitable if consumer preferences change. Initiate estimates indicate there is a 60 percent chance consumer preferences will remain unchanged. The payoff table for this decision is shown below. All figures are in dollars of net profit.

	Consumer preferences	
Decision alternative	Unchanged, $P(U) = 0.6$	Changed, $P(C) = 0.4$
Design A	\$42,000	\$10,000
Design B	\$33,000	\$20,000

(i) Determine the optimal decision for the company if management wishes to maximize expected profit.

(2 marks)

(ii) What is the expected value of perfect information?

(2 marks)

A market research firm has offered, for a fee, to conduct a survey on consumer preferences for the company. Past experience shows that, when consumer preferences are unchanged, the survey will reveal that fact 85 percent of the time (use *RU* denotes reveal unchanged, $P(RU|U) = 0.85$). When consumer preferences have changed, the survey reveals that fact 75 percent of the time (use *RC* denotes reveal changed, $P(RC|C) = 0.75$).

(iii) Apply the Bayes' Theorem to compute joint probabilities and posterior probabilities.

(6 marks)

(iv) Draw a decision tree for this problem.

(5 marks)

(iv) Determine whether the company should conduct the market research survey, and which design should the company use.

(10 marks)

Question 5

Trading volume on the New York Stock Exchange is heaviest during the first half hour (early morning) and last half hour (late afternoon) of the trading day. The early morning trading volumes (millions of shares) for 13 days in January and February are shown here. The probability distribution of trading volumes is approximately normal.

214	202	174	163	198	171	265
212	211	194	201	211	180	

(i) Compute the mean and standard deviation to use as estimates of the population mean and standard deviation (round up to integers).

(5 marks)

(ii) What is the probability that, on a randomly selected day, the early morning trading volume will be less than 180 million shares?

(3 marks)

(iii) What is the probability that, on a randomly selected day, the early morning trading volume will exceed 230 million shares?

(4 marks)

(iv) How many shares would have to be traded for the early morning trading volume on a particular day to be among the busiest 5% of days?

(5 marks)

A sales manager collected the following data on annual sales for new customer accounts and the number of years of experience for a sample of 10 salespersons.

Salesperson	Years of experience	Annual sales ($1000s)
1	1	80
2	3	97
3	4	92
4	4	102
5	6	103
6	8	111
7	10	119
8	10	123
9	11	117
10	13	136

(v) Develop an estimated regression equation that can be used to predict annual sales given the years of experience.

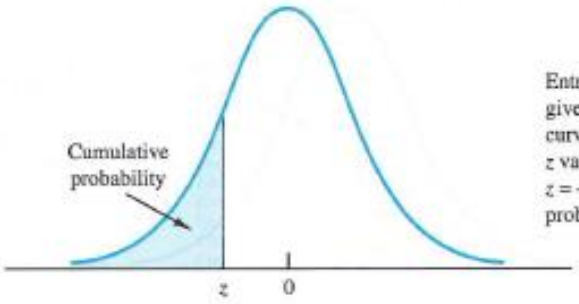
(7 marks)

(vi) Use the regression equation to predict annual sales for a salesperson with 9 years of experience.

(1 mark)

Appendix 1

CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION

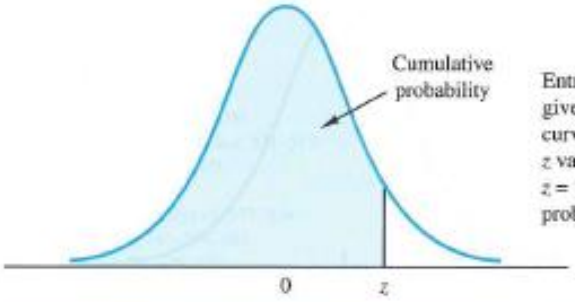


Entries in this table give the area under the curve to the left of the z value. For example, for $z = -.85$, the cumulative probability is .1977.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	.0025	.0024	.0023	.0023	.0022	.0021	.0021	.0020	.0019
−2.7	.0035	.0034	.0033	.0032	.0031	.0030	.0029	.0028	.0027	.0026
−2.6	.0047	.0045	.0044	.0043	.0041	.0040	.0039	.0038	.0037	.0036
−2.5	.0062	.0060	.0059	.0057	.0055	.0054	.0052	.0051	.0049	.0048
−2.4	.0082	.0080	.0078	.0075	.0073	.0071	.0069	.0068	.0066	.0064
−2.3	.0107	.0104	.0102	.0099	.0096	.0094	.0091	.0089	.0087	.0084
−2.2	.0139	.0136	.0132	.0129	.0125	.0122	.0119	.0116	.0113	.0110
−2.1	.0179	.0174	.0170	.0166	.0162	.0158	.0154	.0150	.0146	.0143
−2.0	.0228	.0222	.0217	.0212	.0207	.0202	.0197	.0192	.0188	.0183
−1.9	.0287	.0281	.0274	.0268	.0262	.0256	.0250	.0244	.0239	.0233
−1.8	.0359	.0351	.0344	.0336	.0329	.0322	.0314	.0307	.0301	.0294
−1.7	.0446	.0436	.0427	.0418	.0409	.0401	.0392	.0384	.0375	.0367
−1.6	.0548	.0537	.0526	.0516	.0505	.0495	.0485	.0475	.0465	.0455
−1.5	.0668	.0655	.0643	.0630	.0618	.0606	.0594	.0582	.0571	.0559
−1.4	.0808	.0793	.0778	.0764	.0749	.0735	.0721	.0708	.0694	.0681
−1.3	.0968	.0951	.0934	.0918	.0901	.0885	.0869	.0853	.0838	.0823
−1.2	.1151	.1131	.1112	.1093	.1075	.1056	.1038	.1020	.1003	.0985
−1.1	.1357	.1335	.1314	.1292	.1271	.1251	.1230	.1210	.1190	.1170
−1.0	.1587	.1562	.1539	.1515	.1492	.1469	.1446	.1423	.1401	.1379
−.9	.1841	.1814	.1788	.1762	.1736	.1711	.1685	.1660	.1635	.1611
−.8	.2119	.2090	.2061	.2033	.2005	.1977	.1949	.1922	.1894	.1867
−.7	.2420	.2389	.2358	.2327	.2296	.2266	.2236	.2206	.2177	.2148
−.6	.2743	.2709	.2676	.2643	.2611	.2578	.2546	.2514	.2483	.2451
−.5	.3085	.3050	.3015	.2981	.2946	.2912	.2877	.2843	.2810	.2776
−.4	.3446	.3409	.3372	.3336	.3300	.3264	.3228	.3192	.3156	.3121
−.3	.3821	.3783	.3745	.3707	.3669	.3632	.3594	.3557	.3520	.3483
−.2	.4207	.4168	.4129	.4090	.4052	.4013	.3974	.3936	.3897	.3859
−.1	.4602	.4562	.4522	.4483	.4443	.4404	.4364	.4325	.4286	.4247
−.0	.5000	.4960	.4920	.4880	.4840	.4801	.4761	.4721	.4681	.4641

Appendix 2

CUMULATIVE PROBABILITIES FOR THE STANDARD NORMAL DISTRIBUTION



Entries in the table give the area under the curve to the left of the z value. For example, for $z = 1.25$, the cumulative probability is .8944.

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.6141
.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.7549
.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.8133
.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.8621
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.9015
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.9177
1.4	.9192	.9207	.9222	.9236	.9251	.9265	.9279	.9292	.9306	.9319
1.5	.9332	.9345	.9357	.9370	.9382	.9394	.9406	.9418	.9429	.9441
1.6	.9452	.9463	.9474	.9484	.9495	.9505	.9515	.9525	.9535	.9545
1.7	.9554	.9564	.9573	.9582	.9591	.9599	.9608	.9616	.9625	.9633
1.8	.9641	.9649	.9656	.9664	.9671	.9678	.9686	.9693	.9699	.9706
1.9	.9713	.9719	.9726	.9732	.9738	.9744	.9750	.9756	.9761	.9767
2.0	.9772	.9778	.9783	.9788	.9793	.9798	.9803	.9808	.9812	.9817
2.1	.9821	.9826	.9830	.9834	.9838	.9842	.9846	.9850	.9854	.9857
2.2	.9861	.9864	.9868	.9871	.9875	.9878	.9881	.9884	.9887	.9890
2.3	.9893	.9896	.9898	.9901	.9904	.9906	.9909	.9911	.9913	.9913
2.4	.9918	.9920	.9922	.9925	.9927	.9929	.9931	.9932	.9934	.9936
2.5	.9938	.9940	.9941	.9943	.9945	.9946	.9948	.9949	.9951	.9952
2.6	.9953	.9955	.9956	.9957	.9959	.9960	.9961	.9962	.9963	.9964
2.7	.9965	.9966	.9967	.9968	.9969	.9970	.9971	.9972	.9973	.9974
2.8	.9974	.9975	.9976	.9977	.9977	.9978	.9979	.9979	.9980	.9981
2.9	.9981	.9982	.9982	.9983	.9984	.9984	.9985	.9985	.9986	.9986
3.0	.9986	.9987	.9987	.9988	.9988	.9989	.9989	.9989	.9990	.9990

Appendix 3

1. Expected value, $EV(d_i) = \sum_{j=1}^{N} P(s_j)V_{ij}$

2. Expected value with perfect information (for maximization problems),
$$EVwPI = \sum_{j=1}^{N} P(s_j) \max_i V_{ij}$$

3. Expected value without perfect information (for maximization problems),
$$EVwoPI = \max_i [EV(d_i)] = \max_i \left[\sum_{j=1}^{N} P(s_j)V_{ij} \right]$$

4. Expected value of perfect information, $EVPI = |EVwPI - EVwoPI|$

5. Sample variance, $s^2 = \frac{\sum(x_i - \bar{x})^2}{n-1}$

6. Sample standard deviation, $s = \sqrt{s^2}$

7. Conversion from normal distribution to standard normal distribution,
$$z = \frac{x - \mu}{\sigma}$$

8. Estimated linear regression equation,
$\hat{y} = b_0 + b_1 x$

9. Slope, $b_1 = \frac{\sum_i^n (x_i - \bar{x})(y_i - \bar{y})}{\sum_i^n (x_i - \bar{x})^2}$

10. *Y*-intercept of the regression line, $b_0 = \bar{y} - b_1 \bar{x}$

END OF EXAMINATION PAPER