THE UNIVERSITY OF MELBOURNE

Student ID _____

Semester / Year: Semester 2 2018

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): 13

Authorised Materials: Calculator – Casio FX82 (any suffix)

Instructions to Students:

Write down your stream onto the front page of the answer booklet(s), e.g., Wed1pm, etc.

This examination contributes 50% to the final subject mark.
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: Yes

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

SECTION 1 (compulsory)

Question 1

George, a farmer in west Victoria, is determining what crops to grow on his 120-acre land that was recently bought via an auction. There are two crops he is considering: soybean and corn.

Soybean is more expensive than corn in the market. Specifically, the price for soybean is $9 per bushel and that for corn is $2 per bushel. Based on historical data, the average yield for soybean is 60 bushels per acre and that for corn is 220 bushels per acre. Two key resources used to grow a crop are labor and machine (e.g., harvesters). For simplicity, we consider the following resource requirements: An acre of soybean requires 2 units of labor while an acre of corn requires 3 units of labor. For the machine requirement, an acre of soybean requires 40 hours of machine time while an acre of corn requires 30 hours of machine time. George has secured 350 units of labor and 3,800 hours of machine time.

George's aim is to maximise his total revenue by choosing the optimal area of land on which to grow each of corn and soybean.

Variable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
B16	?	20	0	?	46.66666667	100
C16	?	100	0	?	100	35

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
B21	land use	?	140	?	1.666666667	25
B22	labor	?	0	?	1E+30	10
B23	machine	?	10	?	1000	100

(i) Formulate the linear programming (LP) model for George. (7 marks)

(ii) For the optimal solution, how much land is used to grow each of the two crops, and what is the maximum revenue? (3 marks)

(iii) For the optimal solution, how many units of labor are left unused? (3 marks)

(iv) Would the optimal solution change if the price for corn is increased by $1 per bushel? (3 marks)

(v) What would be the optimal solution if the price of soybean were reduced from $9 to $8.5 per bushel? (3 marks)

(vi) How much would the total revenue increase if the machine time available were increased from 3,800 to 4,000? (3 marks)

(vii) George has an opportunity to sell 10 acres of land at a price of $2,000. Do you recommend him make the sale? (3 marks)

SECTION 2 (answer three out of four questions)

Question 2

(i) Tech Advanced Component Pty. Ltd., a manufacturer of memory cards for computers, and other electronic devices, entered into a contract with an electronics company to produce three different types of memory card for a new line of tablets. The contract calls for followings:

Memory Type	Production Quantity
M-R12	300,000
M-R20	150,000
M-R36	190,000

Tech Advanced Component Pty. Ltd. can manufacture the memory cards at manufacturing facilities located in Germany and Taiwan. The unit cost of the memory cards differs at the two facilities due to differences in production equipment and wage rates. The unit costs for each memory card types at each location are as follows:

	Production Facility	
Product	Taiwan	Germany
M-R12	$0.93	$0.99
M-R20	$0.97	$1.08
M-R36	$1.29	$1.19

M-R12 and M-R20 memory cards are produced using similar production equipment available at both locations. However, each facility has a limited capacity for the total number of M-R12 and M-R20 memory card produced. The combined M-R12 and M-R20 production capacities are 195,000 units at the Taiwan facility and 170,000 units at the Germany facility. The M-R36 production capacities are 85,000 units at the Taiwan facility and 115,000 units at the other facility. The cost of shipping from the Taiwan facility is $0.22 per unit and the cost of shipping from the Germany facility is $0.12 per unit.

Develop an LP/IP model that Tech Advanced Component Pty. Ltd. can use to determine how many units of each memory cards to produce at each facility in order to minimise the total production and shipping cost associated with the newly signed contract.

(13 marks)

(ii) An investment advisor at Shore Financial Services wants to develop a model that can be used to allocate investment funds among four alternatives: stocks, bonds, mutual funds, and cash. For the coming investment period, the company developed estimates of the annual rate of return and the associated risk for each alternative. Risk is measured using an index between 0 and 1, with higher risk values denoting more volatility and thus more uncertainty.

Investment	Annual rate of return (%)	Risk
Stocks	10	0.8
Bonds	3	0.2
Mutual funds	4	0.3
Cash	1	0

The objective is to determine the portion of funds allocated to each investment alternative in order to maximise the total annual return for the portfolio subject to the risk level the client is willing to tolerate.

Total risk is the sum of the risk for all investment alternatives. For instance, if 40% of a client's funds are invested in stocks, 30% in bonds, 20% in mutual funds, and 10% in cash, the total risk for the portfolio would be 0.4(0.8) + 0.3(0.2) + 0.2(0.3) + 0.1(0) = 0.44. An investment advisor will meet with each client to discuss the client's investment objectives and to determine a maximum total risk value for the client. A maximum total risk value of less than 0.3 would be assigned to a conservative investor; a maximum total risk value of between 0.3 and 0.5 would be assigned to a moderate tolerance to risk; and a maximum total risk value greater than 0.5 would be assigned to a more aggressive investor.

Shore Financial Services specified additional guidelines that must be applied to all clients. The guidelines are as follows:

- No more than 75% of the total investment may be in stocks.
- The amount invested in mutual funds must be at least as much as invested in bonds.
- The amount of cash must be at least 10%, but no more than 30% if the total investment funds

Suppose the maximum risk value for a particular client is 0.4, formulate the LP model to determine the optimal allocation of investment funds among stocks, bonds, mutual funds, and cash.

(12 marks)

Question 3

(i) Melbourne is considering the relocation of several police substations to obtain better enforcement in high-crime areas. The locations under consideration together with the areas that can be covered from these locations are given in the following table. Formulate an integer programming model that could be used to find the minimum number of locations necessary to provide coverage of all areas.

Potential Locations for Substations	Areas Covered
1	A, E, G
2	A, B, E, G
3	A, C, E
4	B, D, E
5	C, D, F
6	D, E, F
7	A, E, F, G

(10 marks)

(ii) Uniqlo, a Japanese casual wear design and manufacturing company, decided to enter the Melbourne apparel market in 2014. To boost the sales, Uniqlo opened a number of boutiques in various suburbs of Melbourne. Looking into the sales data of Uniqlo has shown the following annual demand for the major boutiques in Melbourne.

Boutique	Annual demand
Chadstone	6,000
CBD	14,000
Highpoint	8,000
Northland	10,000

To improve the flow of clothes between the warehouses and boutiques, Uniqlo plans to increase the capacity by constructing a new warehouse in one or more of the following suburbs: Box Hill, Blackburn, Mitcham, Ringwood, or Belgrave. The estimated annual fixed cost and the annual capacity for the five proposed warehouses are as follows:

Proposed warehouse	Annual fixed cost	Annual capacity
Box Hill	$2,100,000	12,000
Blackburn	$850,000	18,000
Mitcham	$1,800,000	14,000
Ringwood	$1,100,000	10,000
Belgrave	$900,000	16,000

The shipping cost per unit from each warehouse to each boutique:

	Boutique			
Warehouse	Chadstone	CBD	Highpoint	Northland
Box Hill	56	21	32	65
Blackburn	18	46	7	35
Mitcham	12	71	41	52
Ringwood	30	24	61	28
Belgrave	45	50	26	31

Uniqlo has specified two requirements. First, the company can operate three warehouses at most. Second, if Box Hill was selected, then Blackburn could not be selected, and vice versa. At most, one of them could be selected. Formulate the integer programming model to determine which warehouse(s) should the company operate AND how many products should be shipped from warehouse *i* to boutique *j* to reach the minimum total costs.

(15 marks)

Question 4

Daniel Harrison, a store manager of a local general store in Melrose, is considering signing a new contract with Bellarine Fruits or with a local Melrose farm for daily supplies of fresh strawberries. Bellarine Fruits may reject the contract, but Daniel Harrison may also negotiate to sign the contract for 2 or 5 years. Daniel Harrison must decide to sign the contract with Bellarine Fruits or signing a contract with the local farm at Melrose, but he knows that if he signs with the local Melrose farm, his profits will not be as high in comparison to Bellarine Fruits. If any contract is rejected, it is assumed that there will be a quantifiable cost to the store. Daniel Harrison would like to maximise the store profits and the profits for the different contract lengths are summarised in the following payoff table (in thousands of Australian dollars).

	STATE OF NATURE		
DECISION ALTERNATIVE	**Reject**, s_1	**2 Years**, s_2	**5 Years**, s_3
BELLARINE FRUITS, d_1	-2	3	9
LOCAL MELROSE FARM, d_2	-1	2	5

(i) Apply the Opportunity Loss Approach (with the minimax regret criterion) to recommend a decision to Daniel Harrison.

(2 marks)

Daniel Harrison made an initial assessment on what he thinks Bellarine Fruits and the local Melrose farm may do and came up with the following probabilities:

Bellarine Fruits: P(Reject) = 0.4, P(2 Years) = 0.4, P(5 Years) = 0.2
The local Melrose farm: P(Reject) = 0.1, P(2 Years) = 0.2, P(5 Years) = 0.7

(ii) Draw a decision tree and recommend a decision strategy to Daniel Harrison on whom he should sign the contract with. Clearly show your calculations and provide a justification for your decision strategy.

(5 marks)

For a consulting fee of $1,000, Luca Raymond Consultancy (LRC) will review the plans for the Bellarine Fruits contract and indicate the overall chances of a favourable outcome to Daniel Harrison. Denote favourable review by F, and unfavourable review by U. Daniel Harrison believes that the following conditional probabilities are realistic appraisals of LRC's evaluation accuracy. No review is conducted on the local Melrose farm because there was insufficient information for LRC to do so.

P(F|Rejection) = 0.2, P(F|2 years) = 0.6, P(F|5 years) = 0.8
P(U|Rejection) = 0.8, P(U|2 years) = 0.4, P(U|5 years) = 0.2

(iii) Apply Bayes' Theorem to compute the posterior probabilities for Bellarine Fruits for both the Favourable and Unfavourable review cases.

(6 marks)

(iv) Draw the decision tree, determine the recommended decision strategy(ies) and the expected value for the case where Daniel Harrison has already decided to conduct the review on Bellarine Fruits. Make the assumption that after receiving the review from LRC, Daniel Harrison only has two options of whom he can sign the contract with; namely, Bellarine Fruits or the local Melrose farm. Draw the decision tree with clear labels, show all your calculations and provide justification(s) for your decision strategy(ies) to Daniel Harrison.

(10 marks)

(v) Construct a risk profile for the optimal decision strategy from part (iv).

(2 marks)

Question 5

In 2017, News.com.au reported that the average price per night of a hotel room in Sydney and Melbourne throughout the year is $200 and $170, respectively, with a standard deviation of $40 for Sydney and $30 for Melbourne. Assume that the prices of hotel rooms are normally distributed.

(i) What is the probability that a hotel room in both cities will have a price of at least $250? (4 marks)

(ii) What is the probability that a hotel room in both cities will have a price no higher than $190? (4 marks)

(iii) How high does a hotel room price in Melbourne have to be to put a hotel room price in the top 5%? (3 marks)

Based on a sample of 20 loan applicants from Bank of Melbourne, the following is a table showing their annual salary, work experience in years, age and loan amount approved. A regression output from Excel with loan amount approved as the dependent variable is also shown. An alpha of .05 was used. (Use two decimal places).

Borrower	Annual Salary (AUD$)	Work experience (years)	Age (years)	Loan Amount Approved (AUD$)
1	67,336	2.5	22	385,000
2	62,316	3	24	375,000
3	45,289	4	25	414,000
4	47,780	4.5	25	451,000
5	65,386	5	25	540,000
6	69,122	5.5	7	570,000
7	78,512	6	28	630,000
8	88,965	7.5	28	750,000
9	101,526	10	33	830,000
10	78,956	8	28	679,000
11	98,562	9	29	745,000
12	90,316	6	31	695,000
13	91,752	7	32	678,000
14	96,789	7.5	28	695,000
15	96,358	8	35	705,000
16	98,654	7.5	55	667,000
17	99,995	10.5	61	725,000
18	105,692	12	33	800,000
19	110,698	8	32	677,000
20	117,865	15	31	890,000

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.943421336							
R Square	0.890043818							
Adjusted R Square	0.869427034							
Standard Error	52849.39445							
Observations	20							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	3.61736E+11	1.20579E+11	43.17083643	6.77584E-08			
Residual	16	44688935896	2793058494					
Total	19	4.06425E+11						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	195512.6217	58477.90701	3.343358743	0.004124643	71544.99672	319480.2467	71544.99672	319480.2467
Annual Salary (AUD$)	3.319971149	1.12802527	2.9431709	0.009545187	0.928664401	5.711277896	0.928664401	5.711277896
Work experience (years)	26909.6829	7269.357942	3.701796378	0.001935012	11499.33248	42320.03332	11499.33248	42320.03332
Age (years)	-1037.38018	1263.258319	-0.82119402	0.423603363	-3715.368183	1640.607827	-3715.368183	1640.607827

(iv) Develop an estimated regression equation that can be used to predict loan amount given salary, work experience and age.

(2 marks)

(v) Use the regression equation to predict the amount that can be borrowed by a loan applicant who is 30 years old with 5 years of work experience and has an annual income of $55,000.

(2 marks)

(vi) Predict the loan amount of a borrower who is also 30 years old and with 5 years of experience but earns $80,000. Comparing your results with (v), what conclusions can you draw? Specifically, how much increase/decrease in loan amount approved is added/reduced per $1 increase/decrease in salary?

(4 marks)

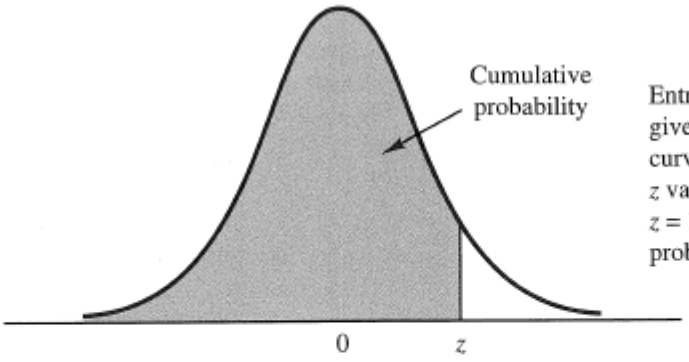
(vii) Describe the overall fit of the model.

(2 marks)

(viii) How would you interpret the coefficient of the *Work experience* variable?

(4 marks)

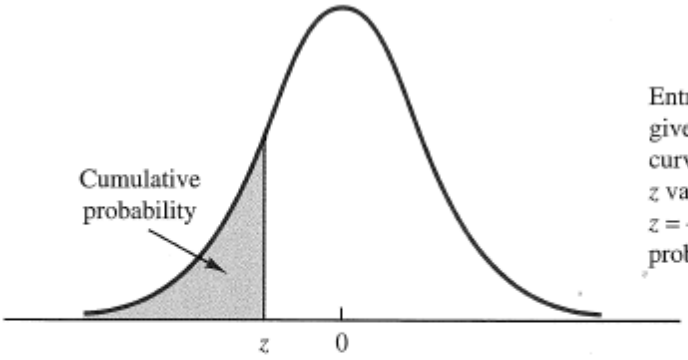
Appendix 1



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 0.8944.

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	0.9913
2.4	0.9916	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
3.0	0.9987	0.9987	0.9987	0.9988	0.9988	0.9989	0.9989	0.9989	0.9990	0.9990

Appendix 2



Entries in the table give the area under the curve to the left of the z value. For example, for $z = -0.85$, the cumulative probability is 0.1977.

z	0.00	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09
−3.0	0.0013	0.0013	0.0013	0.0012	0.0012	0.0011	0.0011	0.0011	0.0010	0.0010
−2.9	0.0019	0.0018	0.0018	0.0017	0.0016	0.0016	0.0015	0.0015	0.0014	0.0014
−2.8	0.0026	0.0025	0.0024	0.0023	0.0023	0.0022	0.0021	0.0021	0.0020	0.0019
−2.7	0.0035	0.0034	0.0033	0.0032	0.0031	0.0030	0.0029	0.0028	0.0027	0.0026
−2.6	0.0047	0.0045	0.0044	0.0043	0.0041	0.0040	0.0039	0.0038	0.0037	0.0036
−2.5	0.0062	0.0060	0.0059	0.0057	0.0055	0.0054	0.0052	0.0051	0.0049	0.0048
−2.4	0.0082	0.0080	0.0078	0.0075	0.0073	0.0071	0.0069	0.0068	0.0066	0.0064
−2.3	0.0107	0.0104	0.0102	0.0099	0.0096	0.0094	0.0091	0.0089	0.0087	0.0084
−2.2	0.0139	0.0136	0.0132	0.0129	0.0125	0.0122	0.0119	0.0116	0.0113	0.0110
−2.1	0.0179	0.0174	0.0170	0.0166	0.0162	0.0158	0.0154	0.0150	0.0146	0.0143
−2.0	0.0228	0.0222	0.0217	0.0212	0.0207	0.0202	0.0197	0.0192	0.0188	0.0183
−1.9	0.0287	0.0281	0.0274	0.0268	0.0262	0.0256	0.0250	0.0244	0.0239	0.0233
−1.8	0.0359	0.0351	0.0344	0.0336	0.0329	0.0322	0.0314	0.0307	0.0301	0.0294
−1.7	0.0446	0.0436	0.0427	0.0418	0.0409	0.0401	0.0392	0.0384	0.0375	0.0367
−1.6	0.0548	0.0537	0.0526	0.0516	0.0505	0.0495	0.0485	0.0475	0.0465	0.0455
−1.5	0.0668	0.0655	0.0643	0.0630	0.0618	0.0606	0.0594	0.0582	0.0571	0.0559
−1.4	0.0808	0.0793	0.0778	0.0764	0.0749	0.0735	0.0721	0.0708	0.0694	0.0681
−1.3	0.0968	0.0951	0.0934	0.0918	0.0901	0.0885	0.0869	0.0853	0.0838	0.0823
−1.2	0.1151	0.1131	0.1112	0.1093	0.1075	0.1056	0.1038	0.1020	0.1003	0.0985
−1.1	0.1357	0.1335	0.1314	0.1292	0.1271	0.1251	0.1230	0.1210	0.1190	0.1170
−1.0	0.1587	0.1562	0.1539	0.1515	0.1492	0.1469	0.1446	0.1423	0.1401	0.1379
−0.9	0.1841	0.1814	0.1788	0.1762	0.1736	0.1711	0.1685	0.1660	0.1635	0.1611
−0.8	0.2119	0.2090	0.2061	0.2033	0.2005	0.1977	0.1949	0.1922	0.1894	0.1867
−0.7	0.2420	0.2389	0.2358	0.2327	0.2296	0.2266	0.2236	0.2206	0.2177	0.2148
−0.6	0.2743	0.2709	0.2676	0.2643	0.2611	0.2578	0.2546	0.2514	0.2483	0.2451
−0.5	0.3085	0.3050	0.3015	0.2981	0.2946	0.2912	0.2877	0.2843	0.2810	0.2776
−0.4	0.3446	0.3409	0.3372	0.3336	0.3300	0.3264	0.3228	0.3192	0.3156	0.3121
−0.3	0.3821	0.3783	0.3745	0.3707	0.3669	0.3632	0.3594	0.3557	0.3520	0.3483
−0.2	0.4207	0.4168	0.4129	0.4090	0.4052	0.4013	0.3974	0.3936	0.3897	0.3859
−0.1	0.4602	0.4562	0.4522	0.4483	0.4443	0.4404	0.4364	0.4325	0.4286	0.4247
−0.0	0.5000	0.4960	0.4920	0.4880	0.4840	0.4801	0.4761	0.4721	0.4681	0.4641

Appendix 3

1. Opportunity loss or regret, $R_{ij} = \left|V_j^* - V_{ij}\right|$

2. Opportunity loss approach, Select d_i with $R = \min_i \left[\max_j \left(R_{ij}\right)\right]$

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

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

5. Sum of squares due to error, SSE = $\sum (y_i - \hat{y}_i)^2$

6. Total sum of squares, SST = $\sum (y_i - \bar{y})^2$

7. Sum of squares due to regression, SSR = $\sum (\hat{y}_i - \bar{y})^2$ OR SSR = SST – SSE

8. Coefficient of determination, $r^2 = \frac{\text{SSR}}{\text{SST}}$

END OF EXAMINATION PAPER