NANYANG TECHNOLOGICAL UNIVERSITY

SEMESTER 2 EXAMINATION 2022-2023

BR2211 Financial and Risk Analytics I

APRIL 2023 Time Allowed: 2 ½ Hours

INSTRUCTIONS

1. This paper contains **FIVE(5)** questions and comprises **NINE(9)** pages of questions and **ONE(1)** appendix of **FIVE(5)** pages.
2. Answer **ALL** questions.
3. This is a **Closed-book** examination.
4. The number of marks allocated is shown at the end of each question.
5. Begin your answer to each question on a separate page of the answer book.
6. Answers will be graded for content and appropriate presentation.

Note: Exam Questions begin on Page 2.

Question 1

(a) Suppose now that the spot rate for a one year treasury bond is 2% per annum effective, and that the spot rate for a three year treasury bond is 3.5% per annum effective. Calculate the arbitrage-free forward rate for a two year treasury bond starting one year from today.

(3 marks)

(b) Briefly describe what are mortgage-backed securities.

(3 marks)

(c) Suppose you are to sell tons of fresh wheat in 6-months' time and you face the risk that the wheat price in 6-months' time may drop. Briefly describe how you can use different types of derivatives to hedge against your wheat price risk. In particular, you need to specify your positions to be taken (long or short, put or call option etc).

(3 marks)

(d) Briefly describe the most common long-term and short-term risks embedded in different types of insurance products.

(4 marks)

(e) With regards to the following statements, state whether they are TRUE or FALSE with brief explanations.

i) When fitting a given set of data with a model, the best model is the one that minimizes the fitting errors, regardless of how complicated the model is.

(3 marks)

ii) Data analysts usually find that there are many "correct" models to fit a given data set.

(3 marks)

(TOTAL: 19 marks)

Question 2

(a) Briefly describe both direct short-term value and indirect long-term value of data.

(4 marks)

(b) Briefly describe the primary objectives at raw, refined and production stages of data analysis respectively.

(6 marks)

(c) The prices of a non-dividend paying stock at different time t given in the table below.

t	P_t
0	102
1	96
2	98
3	107
4	105
5	110

i) Calculate the net return for each period

(2 marks)

ii) Calculate the average return per period of this stock based on the given data.

(1 mark)

iii) Calculate the sample variance of the return of this stock based on the given data.

(1 mark)

Assuming the net return per period follows a normal distribution with mean as calculated in (ii) and variance as calculated in (iii),

iv) Find the shortfall probability with return being lower than 1%;

(2 marks)

v) Find the Value at Risk at 5% probability level.

(3 marks)

(TOTAL: 19 marks)

Question 3

(a) Briefly explain why a standard linear regression model is not appropriate when the response variable is a categorical instead of numerical.

(3 marks)

(b) An analyst aims to model the life expectancy of a given population using a linear regression $Y_i = \mu + \alpha_1 X_{1,i} + \alpha_2 X_{2,i} + \cdots + \alpha_p X_{p,i} + e_i$, where Y_i is the response variable, i.e. the life expectancy of individual i, and $\{X_1, X_2, \ldots, X_p\}$ are the p predict variables.

i) After conducting some basic data investigation, the analyst decided to use the following R-code

lm(`Life expectancy`~Alcohol+`percentage expenditure`+BMI+Schooling)

and have obtained the following results.

```
Call:
lm(formula = `Life expectancy` ~ Alcohol + `percentage expenditure` +
    BMI + Schooling)

Residuals:
     Min       1Q   Median       3Q      Max
-26.9333  -2.8964   0.5495   3.5702  30.6262

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)              4.449e+01  4.805e-01  92.594  < 2e-16 ***
Alcohol                 -1.688e-01  3.530e-02  -4.783 1.82e-06 ***
`percentage expenditure` 5.852e-04  6.195e-05   9.447  < 2e-16 ***
BMI                      1.034e-01  7.111e-03  14.538  < 2e-16 ***
Schooling                1.758e+00  5.018e-02  35.044  < 2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Describe the model implied by the R-code above. Comment on the results above. In particular, comment on the "Residuals" statistics as well as the estimated coefficients of the selected predictors.

(4 marks)

ii) The analyst has Identified another predictor "GDP" and tries another linear regression with the following R-code

lm(`Life expectancy`~Alcohol+`percentage expenditure`+BMI+GDP+Schooling)

and has obtained the following results:

Note: Question No.3 continues on page 5

Question 3 (Continued)

```
Call:
lm(formula = `Life expectancy` ~ Alcohol + `percentage expenditure` +
    BMI + GDP + Schooling)

Residuals:
     Min       1Q   Median       3Q      Max
-26.6724  -3.0987   0.5203   3.7192  30.9166

Coefficients:
                          Estimate Std. Error t value Pr(>|t|)
(Intercept)              4.428e+01  5.053e-01  87.637  < 2e-16 ***
Alcohol                 -1.976e-01  3.817e-02  -5.177 2.44e-07 ***
`percentage expenditure` 9.389e-05  1.471e-04   0.638    0.523
BMI                      1.081e-01  7.697e-03  14.039  < 2e-16 ***
GDP                      8.838e-05  2.248e-05   3.932 8.68e-05 ***
Schooling                1.743e+00  5.329e-02  32.711  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Briefly describe the changes you see in the new model in comparison to the results in part (b)(i).

(5 marks)

iii) In order to analyze the statistical significance of different predictors, the analyst has conducted the following Analysis of Variances (ANOVA).

```
> anova(lm(`Life expectancy`~Alcohol+`percentage expenditure`+BMI+GDP+Schooling))
Analysis of Variance Table

Response: Life expectancy
                           Df Sum Sq Mean Sq  F value    Pr(>F)
Alcohol                     1  32008   32008  889.019 < 2.2e-16 ***
`percentage expenditure`    1  19860   19860  551.597 < 2.2e-16 ***
BMI                         1  41333   41333 1148.002 < 2.2e-16 ***
GDP                         1   2843    2843   78.958 < 2.2e-16 ***
Schooling                   1  38525   38525 1070.026 < 2.2e-16 ***
Residuals                2305  82989      36
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
> anova(lm(`Life expectancy`~Alcohol+BMI+GDP+Schooling+`percentage expenditure`))
Analysis of Variance Table

Response: Life expectancy
                           Df Sum Sq Mean Sq   F value Pr(>F)
Alcohol                     1  32008   32008  889.0189 <2e-16 ***
BMI                         1  49733   49733 1381.3269 <2e-16 ***
GDP                         1  14292   14292  396.9616 <2e-16 ***
Schooling                   1  38520   38520 1069.8876 <2e-16 ***
`percentage expenditure`    1     15      15    0.4072 0.5235
Residuals                2305  82989      36
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

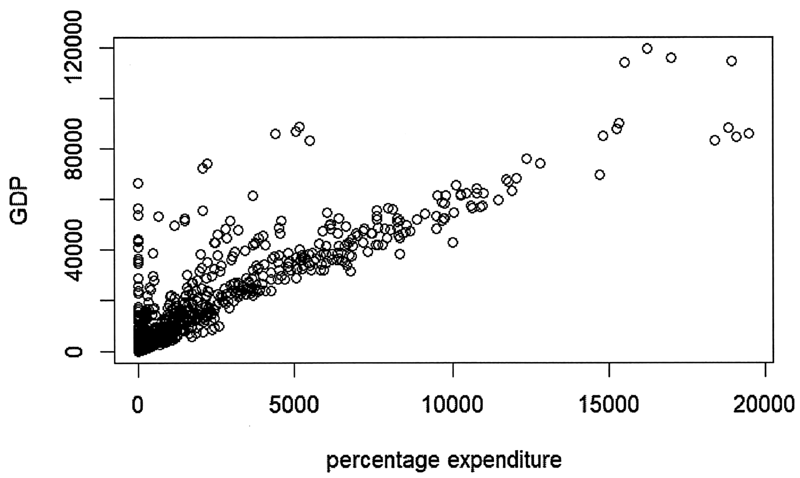
Note: Question No.3 continues on page 6

Question 3 (Continued)

Briefly explain the differences between the two ANOVA table and why the results from the ANOVA are different even when the predictor variables used in the linear regressions are the same.

(4 marks)

iv) The analyst then obtained a scatterplot of "percentage expenditure" and "GDP". Briefly explain the possible reasons for "percentage expenditure" to become insignificant in the linear model when the "GDP" predictor is included in the model.



(4 marks)

v) The analyst then used a "stepAIC" function to trim down the model based on the AIC criteria. He has obtained the following results:

Note: Question No.3 continues on page 7

Question 3 (Continued)

```
> stepAIC(fit1)
Start:  AIC=8287.76
`Life expectancy` ~ Alcohol + `percentage expenditure` + BMI +
    GDP + Schooling

                          Df Sum of Sq    RSS    AIC
- `percentage expenditure`  1        15  83004 8286.2
<none>                                   82989 8287.8
- GDP                       1       557  83546 8301.2
- Alcohol                   1       965  83954 8312.5
- BMI                       1      7096  90085 8475.4
- Schooling                 1     38525 121514 9167.0

Step:  AIC=8286.17
`Life expectancy` ~ Alcohol + BMI + GDP + Schooling

            Df Sum of Sq    RSS    AIC
<none>                    83004 8286.2
- Alcohol    1       952  83956 8310.5
- GDP        1      3887  86891 8389.9
- BMI        1      7081  90085 8473.4
- Schooling  1     38520 121524 9165.2

Call:
lm(formula = `Life expectancy` ~ Alcohol + BMI + GDP + Schooling)

Coefficients:
(Intercept)      Alcohol          BMI          GDP    Schooling
 44.2765690   -0.1936927    0.1078332    0.0001013    1.7419111
```

Briefly describe the steps taken by the "stepAIC" function and how it determines which predictors need to be excluded in the model.

(6 marks)

vi) Based on the "best" model from the stepAIC, predict the life expectancy of a person who has the following given information:

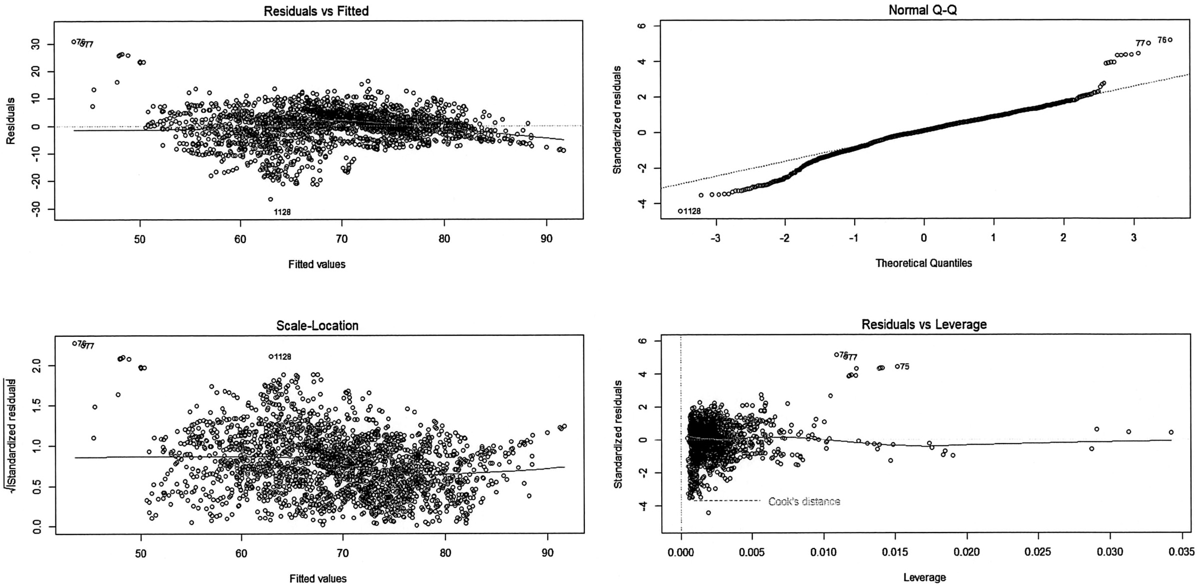
Alcohol=0.03, BMI=15.7, GDP=445.89, Schooling=8.7.

(2 marks)

vii) The analyst then obtained a model summary plot for the final model determined by the "stepAIC" function.

Note: Question No.3 continues on page 8

Question 3 (Continued)



Briefly describe the information provided by each of the four plots. Comment on the results based on the plots provided.

(8 marks)

(TOTAL: 36 marks)

Question 4

(a) Suppose that $\{X_t\}_{t\geq 0}$ is a sequence of random variables. Let B be the backward shifting operator and ∇ be the differencing operator that operate on time series.

i) Expand $\nabla^3 X_t - B^2 X_t$

(4 marks)

ii) Give an expression for $X_t - 5X_{t-1} + 7X_{t-2} - 3X_{t-3}$ in terms of second order differences operator (∇^2).

(4 marks)

(b) For a moving average MA(2) model where the sequence of random variables $\{Y_t\}_{t\geq 0}$ are defined as $Y_t = \mu + e_t + \beta_1 e_{t-1} + \beta_2 e_{t-2}$, where $\{e_t\}_{t\geq 0}$ are white noise processes with mean 0 and standard deviation of σ.

Note: Question No.4 continues on page 9

Question 4 (Continued)

i) Derive the autocovariance function $\gamma_k = Cov(Y_t, Y_{t+k})$, for $0 \leq k \leq 3$ for this process.

(8 marks)

ii) Hence or otherwise write down the autocorrelation function ρ_k, for $0 \leq k \leq 3$ for this process.

(3 marks)

(TOTAL: 19 marks)

Question 5

A company is carrying out an assessment of the expected value $E[Y]$ where $Y = \sqrt{X}$ and X follows a Pareto distribution with cumulative density function $F(x) = 1 - \left(\frac{\lambda}{\lambda+x}\right)^{\alpha}$. In order to estimate $E(Y)$, the analyst determined to use a Monte-Carlo simulation.

Set out an algorithm for generating simulated values of Y using the inverse transform method. Clearly indicate the steps taking for the generating process.

(7 marks)

- END OF PAPER -

Appendix: BR2211 Formulae and Tables

SAMPLE MEAN AND VARIANCE

The random sample $(x_1, x_2, \ldots, x_n)$ has the following sample moments:

Sample mean: $\bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$

Sample variance: $s^2 = \frac{1}{n-1}\left\{\sum_{i=1}^{n} x_i^2 - n\bar{x}^2\right\}$

LINEAR REGRESSION MODEL WITH NORMAL ERRORS

Model

$$Y_i \sim N(\alpha + \beta x_i, \sigma^2), \quad i = 1, 2, \ldots, n$$

Intermediate calculations

$$s_{xx} = \sum_{i=1}^{n}(x_i - \bar{x})^2 = \sum_{i=1}^{n} x_i^2 - n\bar{x}^2$$

$$s_{yy} = \sum_{i=1}^{n}(y_i - \bar{y})^2 = \sum_{i=1}^{n} y_i^2 - n\bar{y}^2$$

$$s_{xy} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n} x_i y_i - n\bar{x}\,\bar{y}$$

Sum of squares relationship

$$\sum_{i=1}^{n}(y_i - \bar{y})^2 = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 + \sum_{i=1}^{n}(\hat{y}_i - \bar{y})^2$$

Note: Appendix continues on page 11

Appendix (Continued)

ANALYSIS OF VARIANCE

Single factor normal model

$$Y_{ij} \sim N(\mu + \tau_i, \sigma^2), \quad i = 1, 2, \ldots, k, \quad j = 1, 2, \ldots, n_i$$

where $n = \sum_{i=1}^{k} n_i$, with $\sum_{i=1}^{k} n_i \tau_i = 0$

Intermediate calculations (sums of squares)

Total: $$SS_T = \sum_{i=1}^{k} \sum_{j=1}^{n_i} (y_{ij} - \bar{y}_{\cdot\cdot})^2 = \sum_{i=1}^{k} \sum_{j=1}^{n_i} y_{ij}^2 - \frac{y_{\cdot\cdot}^2}{n}$$

Between treatments: $$SS_B = \sum_{i=1}^{k} n_i (\bar{y}_{i\cdot} - \bar{y}_{\cdot\cdot})^2 = \sum_{i=1}^{k} \frac{y_{i\cdot}^2}{n_i} - \frac{y_{\cdot\cdot}^2}{n}$$

Residual: $$SS_R = SS_T - SS_B$$

Variance estimate

$$\hat{\sigma}^2 = \frac{SS_R}{n - k}$$

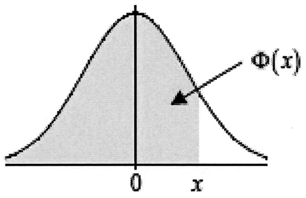
Note: Appendix continues on page 12

Appendix (Continued)

Probabilities for the Standard Normal distribution

The distribution function is denoted by $\Phi(x)$, and the probability density function is denoted by $\phi(x)$.

$$\Phi(x) = \int_{-\infty}^{x} \phi(t)dt = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{x} e^{-\frac{1}{2}t^2} dt$$



x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$
0.00	0.50000	**0.40**	0.65542	**0.80**	0.78814	**1.20**	0.88493	**1.60**	0.94520
0.01	0.50399	**0.41**	0.65910	**0.81**	0.79103	**1.21**	0.88686	**1.61**	0.94630
0.02	0.50798	**0.42**	0.66276	**0.82**	0.79389	**1.22**	0.88877	**1.62**	0.94738
0.03	0.51197	**0.43**	0.66640	**0.83**	0.79673	**1.23**	0.89065	**1.63**	0.94845
0.04	0.51595	**0.44**	0.67003	**0.84**	0.79955	**1.24**	0.89251	**1.64**	0.94950
0.05	0.51994	**0.45**	0.67364	**0.85**	0.80234	**1.25**	0.89435	**1.65**	0.95053
0.06	0.52392	**0.46**	0.67724	**0.86**	0.80511	**1.26**	0.89617	**1.66**	0.95154
0.07	0.52790	**0.47**	0.68082	**0.87**	0.80785	**1.27**	0.89796	**1.67**	0.95254
0.08	0.53188	**0.48**	0.68439	**0.88**	0.81057	**1.28**	0.89973	**1.68**	0.95352
0.09	0.53586	**0.49**	0.68793	**0.89**	0.81327	**1.29**	0.90147	**1.69**	0.95449
0.10	0.53983	**0.50**	0.69146	**0.90**	0.81594	**1.30**	0.90320	**1.70**	0.95543
0.11	0.54380	**0.51**	0.69497	**0.91**	0.81859	**1.31**	0.90490	**1.71**	0.95637
0.12	0.54776	**0.52**	0.69847	**0.92**	0.82121	**1.32**	0.90658	**1.72**	0.95728
0.13	0.55172	**0.53**	0.70194	**0.93**	0.82381	**1.33**	0.90824	**1.73**	0.95818
0.14	0.55567	**0.54**	0.70540	**0.94**	0.82639	**1.34**	0.90988	**1.74**	0.95907
0.15	0.55962	**0.55**	0.70884	**0.95**	0.82894	**1.35**	0.91149	**1.75**	0.95994
0.16	0.56356	**0.56**	0.71226	**0.96**	0.83147	**1.36**	0.91309	**1.76**	0.96080
0.17	0.56749	**0.57**	0.71566	**0.97**	0.83398	**1.37**	0.91466	**1.77**	0.96164
0.18	0.57142	**0.58**	0.71904	**0.98**	0.83646	**1.38**	0.91621	**1.78**	0.96246
0.19	0.57535	**0.59**	0.72240	**0.99**	0.83891	**1.39**	0.91774	**1.79**	0.96327
0.20	0.57926	**0.60**	0.72575	**1.00**	0.84134	**1.40**	0.91924	**1.80**	0.96407
0.21	0.58317	**0.61**	0.72907	**1.01**	0.84375	**1.41**	0.92073	**1.81**	0.96485
0.22	0.58706	**0.62**	0.73237	**1.02**	0.84614	**1.42**	0.92220	**1.82**	0.96562
0.23	0.59095	**0.63**	0.73565	**1.03**	0.84849	**1.43**	0.92364	**1.83**	0.96638
0.24	0.59483	**0.64**	0.73891	**1.04**	0.85083	**1.44**	0.92507	**1.84**	0.96712
0.25	0.59871	**0.65**	0.74215	**1.05**	0.85314	**1.45**	0.92647	**1.85**	0.96784
0.26	0.60257	**0.66**	0.74537	**1.06**	0.85543	**1.46**	0.92785	**1.86**	0.96856
0.27	0.60642	**0.67**	0.74857	**1.07**	0.85769	**1.47**	0.92922	**1.87**	0.96926
0.28	0.61026	**0.68**	0.75175	**1.08**	0.85993	**1.48**	0.93056	**1.88**	0.96995
0.29	0.61409	**0.69**	0.75490	**1.09**	0.86214	**1.49**	0.93189	**1.89**	0.97062
0.30	0.61791	**0.70**	0.75804	**1.10**	0.86433	**1.50**	0.93319	**1.90**	0.97128
0.31	0.62172	**0.71**	0.76115	**1.11**	0.86650	**1.51**	0.93448	**1.91**	0.97193
0.32	0.62552	**0.72**	0.76424	**1.12**	0.86864	**1.52**	0.93574	**1.92**	0.97257
0.33	0.62930	**0.73**	0.76730	**1.13**	0.87076	**1.53**	0.93699	**1.93**	0.97320
0.34	0.63307	**0.74**	0.77035	**1.14**	0.87286	**1.54**	0.93822	**1.94**	0.97381
0.35	0.63683	**0.75**	0.77337	**1.15**	0.87493	**1.55**	0.93943	**1.95**	0.97441
0.36	0.64058	**0.76**	0.77637	**1.16**	0.87698	**1.56**	0.94062	**1.96**	0.97500
0.37	0.64431	**0.77**	0.77935	**1.17**	0.87900	**1.57**	0.94179	**1.97**	0.97558
0.38	0.64803	**0.78**	0.78230	**1.18**	0.88100	**1.58**	0.94295	**1.98**	0.97615
0.39	0.65173	**0.79**	0.78524	**1.19**	0.88298	**1.59**	0.94408	**1.99**	0.97670
0.40	0.65542	**0.80**	0.78814	**1.20**	0.88493	**1.60**	0.94520	**2.00**	0.97725

Note: Appendix continues on page 13

Appendix (Continued)

Probabilities for the Standard Normal distribution

x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$	x	$\Phi(x)$
2.00	0.97725	2.40	0.99180	2.80	0.99744	3.20	0.99931	3.60	0.99984	4.00	0.99997
2.01	0.97778	2.41	0.99202	2.81	0.99752	3.21	0.99934	3.61	0.99985	4.01	0.99997
2.02	0.97831	2.42	0.99224	2.82	0.99760	3.22	0.99936	3.62	0.99985	4.02	0.99997
2.03	0.97882	2.43	0.99245	2.83	0.99767	3.23	0.99938	3.63	0.99986	4.03	0.99997
2.04	0.97932	2.44	0.99266	2.84	0.99774	3.24	0.99940	3.64	0.99986	4.04	0.99997
2.05	0.97982	2.45	0.99286	2.85	0.99781	3.25	0.99942	3.65	0.99987	4.05	0.99997
2.06	0.98030	2.46	0.99305	2.86	0.99788	3.26	0.99944	3.66	0.99987	4.06	0.99998
2.07	0.98077	2.47	0.99324	2.87	0.99795	3.27	0.99946	3.67	0.99988	4.07	0.99998
2.08	0.98124	2.48	0.99343	2.88	0.99801	3.28	0.99948	3.68	0.99988	4.08	0.99998
2.09	0.98169	2.49	0.99361	2.89	0.99807	3.29	0.99950	3.69	0.99989	4.09	0.99998
2.10	0.98214	2.50	0.99379	2.90	0.99813	3.30	0.99952	3.70	0.99989	4.10	0.99998
2.11	0.98257	2.51	0.99396	2.91	0.99819	3.31	0.99953	3.71	0.99990	4.11	0.99998
2.12	0.98300	2.52	0.99413	2.92	0.99825	3.32	0.99955	3.72	0.99990	4.12	0.99998
2.13	0.98341	2.53	0.99430	2.93	0.99831	3.33	0.99957	3.73	0.99990	4.13	0.99998
2.14	0.98382	2.54	0.99446	2.94	0.99836	3.34	0.99958	3.74	0.99991	4.14	0.99998
2.15	0.98422	2.55	0.99461	2.95	0.99841	3.35	0.99960	3.75	0.99991	4.15	0.99998
2.16	0.98461	2.56	0.99477	2.96	0.99846	3.36	0.99961	3.76	0.99992	4.16	0.99998
2.17	0.98500	2.57	0.99492	2.97	0.99851	3.37	0.99962	3.77	0.99992	4.17	0.99998
2.18	0.98537	2.58	0.99506	2.98	0.99856	3.38	0.99964	3.78	0.99992	4.18	0.99999
2.19	0.98574	2.59	0.99520	2.99	0.99861	3.39	0.99965	3.79	0.99992	4.19	0.99999
2.20	0.98610	2.60	0.99534	3.00	0.99865	3.40	0.99966	3.80	0.99993	4.20	0.99999
2.21	0.98645	2.61	0.99547	3.01	0.99869	3.41	0.99968	3.81	0.99993	4.21	0.99999
2.22	0.98679	2.62	0.99560	3.02	0.99874	3.42	0.99969	3.82	0.99993	4.22	0.99999
2.23	0.98713	2.63	0.99573	3.03	0.99878	3.43	0.99970	3.83	0.99994	4.23	0.99999
2.24	0.98745	2.64	0.99585	3.04	0.99882	3.44	0.99971	3.84	0.99994	4.24	0.99999
2.25	0.98778	2.65	0.99598	3.05	0.99886	3.45	0.99972	3.85	0.99994	4.25	0.99999
2.26	0.98809	2.66	0.99609	3.06	0.99889	3.46	0.99973	3.86	0.99994	4.26	0.99999
2.27	0.98840	2.67	0.99621	3.07	0.99893	3.47	0.99974	3.87	0.99995	4.27	0.99999
2.28	0.98870	2.68	0.99632	3.08	0.99896	3.48	0.99975	3.88	0.99995	4.28	0.99999
2.29	0.98899	2.69	0.99643	3.09	0.99900	3.49	0.99976	3.89	0.99995	4.29	0.99999
2.30	0.98928	2.70	0.99653	3.10	0.99903	3.50	0.99977	3.90	0.99995	4.30	0.99999
2.31	0.98956	2.71	0.99664	3.11	0.99906	3.51	0.99978	3.91	0.99995	4.31	0.99999
2.32	0.98983	2.72	0.99674	3.12	0.99910	3.52	0.99978	3.92	0.99996	4.32	0.99999
2.33	0.99010	2.73	0.99683	3.13	0.99913	3.53	0.99979	3.93	0.99996	4.33	0.99999
2.34	0.99036	2.74	0.99693	3.14	0.99916	3.54	0.99980	3.94	0.99996	4.34	0.99999
2.35	0.99061	2.75	0.99702	3.15	0.99918	3.55	0.99981	3.95	0.99996	4.35	0.99999
2.36	0.99086	2.76	0.99711	3.16	0.99921	3.56	0.99981	3.96	0.99996	4.36	0.99999
2.37	0.99111	2.77	0.99720	3.17	0.99924	3.57	0.99982	3.97	0.99996	4.37	0.99999
2.38	0.99134	2.78	0.99728	3.18	0.99926	3.58	0.99983	3.98	0.99997	4.38	0.99999
2.39	0.99158	2.79	0.99736	3.19	0.99929	3.59	0.99983	3.99	0.99997	4.39	0.99999
2.40	0.99180	2.80	0.99744	3.20	0.99931	3.60	0.99984	4.00	0.99997	4.40	0.99999

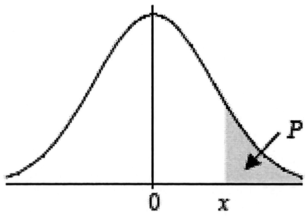
Note: Appendix continues on page 14

Appendix (Continued)

Percentage Points for the Standard Normal distribution

The table gives percentage points x defined by the equation

$$P = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-\frac{1}{2}t^2}\, dt$$



P	x	P	x	P	x	P	x	P	x	P	x
50%	0.0000	5.0%	1.6449	3.0%	1.8808	2.0%	2.0537	1.0%	2.3263	0.10%	3.0902
45%	0.1257	4.8%	1.6646	2.9%	1.8957	1.9%	2.0749	0.9%	2.3656	0.09%	3.1214
40%	0.2533	4.6%	1.6849	2.8%	1.9110	1.8%	2.0969	0.8%	2.4089	0.08%	3.1559
35%	0.3853	4.4%	1.7060	2.7%	1.9268	1.7%	2.1201	0.7%	2.4573	0.07%	3.1947
30%	0.5244	4.2%	1.7279	2.6%	1.9431	1.6%	2.1444	0.6%	2.5121	0.06%	3.2389
25%	0.6745	4.0%	1.7507	2.5%	1.9600	1.5%	2.1701	0.5%	2.5758	0.05%	3.2905
20%	0.8416	3.8%	1.7744	2.4%	1.9774	1.4%	2.1973	0.4%	2.6521	0.01%	3.7190
15%	1.0364	3.6%	1.7991	2.3%	1.9954	1.3%	2.2262	0.3%	2.7478	0.005%	3.8906
10%	1.2816	3.4%	1.8250	2.2%	2.0141	1.2%	2.2571	0.2%	2.8782	0.001%	4.2649
5%	1.6449	3.2%	1.8522	2.1%	2.0335	1.1%	2.2904	0.1%	3.0902	0.0005%	4.4172

– END OF APPENDIX –

BR2211 FINANCIAL & RISK ANALYTICS I

Please read the following instructions carefully:

1. **Please do not turn over the question paper until you are told to do so. Disciplinary action may be taken against you if you do so.**

2. You are not allowed to leave the examination hall unless accompanied by an invigilator. You may raise your hand if you need to communicate with the invigilator.

3. Please write your Matriculation Number on the front of the answer book.

4. Please indicate clearly in the answer book (at the appropriate place) if you are continuing the answer to a question elsewhere in the book.