# RMIT

**FACULTY OF BUSINESS**
**School of Marketing**

**PR220 PROPERTY DATA ANALYSIS II**

**DATE:** **Wednesday 17th November, 1999**
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**TIME: 2.00 — 4.00 PM**

**TIME ALLOWED:** TWO (2) HOURS

**This exam counts for 50% of the total marks in PR220**

| |
|---|
| **Students must attempt Part B of the paper to be eligible for the award of distinction or better in this subject.** |

## INSTRUCTIONS

1. Carry out these instructions and those printed on the front cover of the Examination Book.

2. **All students must attempt part A of the paper.**

3. Calculators are allowed.

4. Stationery supplied — Formula sheet
   — Normal distribution tables.
   — t - distribution tables.
   — F - distribution tables.

# Part A - All questions are Compulsory

## Question 1

A developer is interested in maximising the profit contribution from each unit in a development and wishes to know, among other things, how best to arrange each property on the block to maximise buyer satisfaction.

The developer has conducted a survey of buyer preferences from those who have purchased properties in other subdivisions. The results of this survey contain information about the style of building, the position of the property on the block, distance from shops and other facilities, access to block from street, public transport availability, nature of motor vehicle access, and other information relating to buyer preferences.

The developer is now anxious to analyse this data and incorporate the analysis in an upcoming development. The analysis requires the use of **Principal Components** and **Factor** analysis.

(i) Briefly explain the methodology of these techniques and areas of application.

(ii) Explain how these techniques could assist in the above analysis.

(10 + 10 = 20 marks)

## Question 2

(i) Are exponential smoothing models better than decomposition methods for forecasting? Discuss the merits of each.

(ii) Data for the number of apartments rented each year by a property manager are as follows:

| Year | Time | No. rented | Year | Time | No. rented |
|---|---|---|---|---|---|
| 1984 | 1 | 654 | 1992 | 9 | 701 |
| 1985 | 2 | 658 | 1993 | 10 | 703 |
| 1986 | 3 | 665 | 1994 | 11 | 702 |
| 1987 | 4 | 672 | 1995 | 12 | 710 |
| 1988 | 5 | 673 | 1996 | 13 | 712 |
| 1989 | 6 | 671 | 1997 | 14 | 711 |
| 1990 | 7 | 693 | 1998 | 15 | 728 |
| 1991 | 8 | 694 | **1999** | **16** | **?** |
| | | | **2000** | **17** | **?** |

The property manager wishes to forecast the number of apartments that will be rented in 1999 and 2000. A chart of the data is provided below. **One** of the following four models is suitable for this purpose. Select the model (one only) that you consider best achieves this purpose and justify your explanation.

### Model 1 - Trend equation

| | *Coefficients* | *Standard Error* | *t Stat* |
|---|---|---|---|
| Intercept | 650.31 | 2.72 | 239.28 |
| Time | 4.94 | 0.30 | 16.51 |

| | |
|---|---|
| R Square | 0.954 |
| Adj. R Square | 0.951 |
| Std Error | 5.002 |
| F | 272.643 |

**Model 2 - First order autoregressive**

| | *Coefficients* | *Standard Error* | *t Stat* | | |
|---|---|---|---|---|---|
| | | | | R Square | 0.893 |
| Intercept | 32.03 | 65.93 | 0.49 | Adj. R Square | 0.884 |
| $Y_{t-1}$ | 0.96 | 0.10 | 10.02 | Std Error | 7.167 |
| | | | | F | 100.392 |

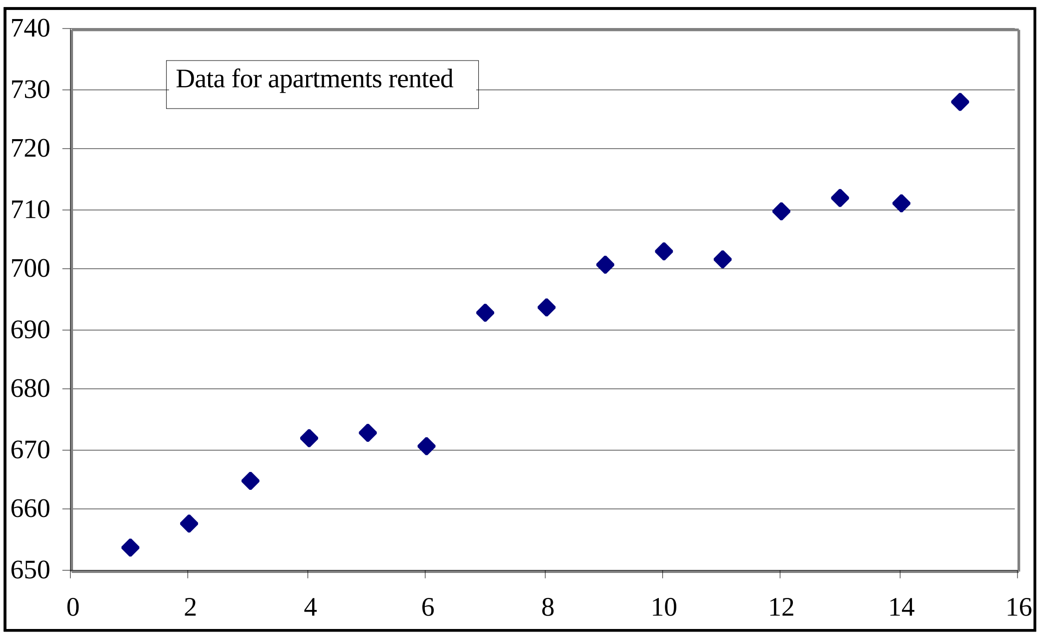
**Model 3 - Second order autoregressive**

| | *Coefficients* | *Standard Error* | *t Stat* | | |
|---|---|---|---|---|---|
| | | | | R Square | 0.892 |
| Intercept | 52.13 | 72.48 | 0.72 | Adj. R Square | 0.871 |
| $Y_{t-1}$ | 0.43 | 0.34 | 1.27 | Std Error | 6.965 |
| $Y_{t-2}$ | 0.51 | 0.32 | 1.59 | F | 41.405 |

**Model 4 - Second order autoregressive with time trend**

| | *Coefficients* | *Standard Error* | *t Stat* | | |
|---|---|---|---|---|---|
| Intercept | 724.25 | 305.68 | 2.37 | R Square | 0.931 |
| Time | 5.38 | 2.40 | 2.24 | Adj. R Square | 0.908 |
| $Y_{t-1}$ | 0.01 | 0.34 | 0.03 | Std Error | 5.879 |
| $Y_{t-2}$ | -0.12 | 0.39 | -0.32 | F | 40.424 |

**Chart of the Data:**




(iii) Discuss the most common deficiencies of predictive models.

(7 + 7 + 6 = 20 marks)

**Question 3**

The following activities have been identified for a small residential subdivision.

| Activity | Description | Activity Predecessor | Mean completion time (weeks) | Activity Variance |
|---|---|---|---|---|
| a | Purchase land | - | 9 | 4 |
| b | Subdivision design and approval | - | 5 | 2 |
| c | Secure contractors | a | 3 | 2 |
| d | Site drainage | a | 8 | 5 |
| e | Excavation for Stage 1 | c | 4 | 2 |
| f | Install basic services (Sewer, gas, electricity & water) | a,b | 11 | 3 |
| g | Prepare designs and specifications | a,b | 6 | 1 |
| h | Excavate and pour foundations | d,e,f,g | 2 | 1 |
| i | Erect building frames and windows | h | 7 | 2 |
| j | Brickwork and door frames | i | 5 | 3 |
| k | Electrical & plumbing stage 1 | i | 3 | 1 |
| l | Plaster, roof, doors & ventilation | i | 4 | 2 |
| m | Painting, complete electrical & plumbing | j,k,l | 6 | 3 |
| n | Driveways, fence & garden | j | 1 | 1 |

Complete the following:

(i) Construct a network diagram for the project

(ii) Identify the project critical path and interpret its meaning.

(iiii) What is the mean project time and the standard deviation?

(iv) What is the probability of completing the project within 30 weeks ?

(vii) Suppose that it was possible to crash the following activities:

| Activity | Normal time | Crash time |
|---|---|---|
| j | 5 | 2 |
| m | 6 | 4 |

What is the maximum time these activities may be crashed?
Explain your reasoning.

(12 + 5 + 3 + 5 + 5 = 30 marks)

## Part B - Optional

**To be eligible to obtain a distinction or a high distinction in PR220, students must attempt this question.**

### Question 4

A developer of inner city apartments units has taken a sample of 78 apartments and has extracted revenue generated for each apartment from the corporate database. He believes that the revenue received is determined by the price charged and the advertising expenditure allocated to each apartment.

The proposed model assumes that revenue received by the developer is explained by price and advertising. Further, it is contended that while advertising increases revenue, there is some limit to advertising expenditure(that is, after some level of advertising expenditure, increased units of advertising add more to cost than revenue).

The hypothesised model is:

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \qquad \text{where } \begin{cases} X_1 \sim \text{price in \$'000} \\ X_2 \sim \text{advertising in \$} \\ X_3 \sim \text{Advertising squared} \end{cases}$$

$$\begin{bmatrix} \sum Y_i \\ \sum X_{i1} Y_i \\ \sum X_{i2} Y_i \\ \sum X_{i3} Y_i \end{bmatrix} = \begin{bmatrix} n & \sum X_{i1} & \sum X_{i2} & \sum X_{i3} \\ \sum X_{i1} & \sum X_{i1}^2 & \sum X_{i2} X_{i1} & \sum X_{i3} X_{i1} \\ \sum X_{i2} & \sum X_{i1} X_{i2} & \sum X_{i2}^2 & \sum X_{i3} X_{i2} \\ \sum X_{i3} & \sum X_{i1} X_{i3} & \sum X_{i2} X_{i3} & \sum X_{i3}^2 \end{bmatrix} \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

$$\begin{bmatrix} 19{,}005 \\ 5{,}308{,}292 \\ 3{,}481{,}158 \\ 808{,}841{,}117 \end{bmatrix} = \begin{bmatrix} 78 & 21{,}696 & 13{,}402 & 2{,}989{,}630 \\ 21{,}696 & 6{,}318{,}946 & 3{,}915{,}305 & 903{,}885{,}764 \\ 13{,}402 & 3{,}915{,}305 & 2{,}989{,}630 & 775{,}253{,}497 \\ 2{,}989{,}630 & 903{,}885{,}764 & 775{,}253{,}497 & 221{,}024{,}683{,}935 \end{bmatrix} \begin{bmatrix} b_0 \\ b_1 \\ b_2 \\ b_3 \end{bmatrix}$$

Solving this system for $\underline{b}$ produces: $\underline{b} = (X'X)^{-1}X'Y$

$$\underline{b} = \begin{bmatrix} 0.399592142137 & -0.001007569146 & -0.001532621462 & 0.000004091240 \\ -0.001007569146 & 0.000004293552 & -0.000000964613 & -0.000000000547 \\ -0.001532621462 & -0.000000964613 & 0.000022879896 & -0.000000055577 \\ 0.000004091240 & -0.000000000547 & -0.000000055577 & 0.000000000146 \end{bmatrix} \begin{bmatrix} 19{,}005 \\ 5{,}308{,}292 \\ 3{,}481{,}158 \\ 808{,}841{,}117 \end{bmatrix}$$

Model statistics are:

| beta | VAR(beta) | Std Error | t-stat | | |
|---|---|---|---|---|---|
| 219.499 | 55.27043999 | 7.4344 | 29.52 | SSE | 10235.46 |
| -0.15711 | 0.00059387 | 0.0244 | -6.45 | SSR | 74040.35 |
| 0.44835 | 0.00316468 | 0.0563 | 7.97 | SST | 84275.81 |
| -0.00024 | 0.00000002 | 0.0001 | -1.68 | VAR(error) | 138.32 |
| | | | | $S_e$ | 11.76 |

$$S_e^2(X'X)^{-1} = \begin{bmatrix} 55.27039999112 & -0.13936397603 & -0.21198765523 & 0.00056588821 \\ -0.13936397603 & 0.00059387134 & -0.00013342242 & -0.00000007560 \\ -0.21198765523 & -0.00013342242 & 0.00316467932 & -0.00000768722 \\ 0.00056588821 & -0.00000007560 & -0.00000768722 & 0.00000002024 \end{bmatrix}$$

Revenue = $Y = b_0 + b_1P + b_2A + b_3A^2$

The rate of change in total revenue for a unit change in advertising may be obtained from:

$$\text{Marginal revenue from Advertising} = \frac{\partial(Y)}{\partial(\text{Advert})} = b_2 + 2b_3A$$

(i) Briefly evaluate the model. Are the results consistent with the developers expectations. Carry out an F-test on the model to determine if it is significant at $\alpha = 0.01$.

(ii) Test the hypothesis that the optimal level of advertising expenditure per apartment unit is \$4,000 (A = 4000), test at $\alpha = 0.01$.

To test the hypothesis that \$4,000 is the optimal level of advertising expenditure per unit: [i.e. $b_2 + 2b_3(4000)$]

$H_0$: $\beta_2 + 8000\beta_3 = 1$

$H_1$: $\beta_2 + 8000\beta_3 \neq 1$

Construct a t-test of the form:

$$t = \frac{\text{(value based on sample)} - \text{(hypothesised value)}}{\text{sample standard error}}$$

$$t = \frac{(b_2 + 8000b_3) - (\beta_2 + 8000\beta_3)}{\sqrt{\widehat{\text{var}}(b_2 + 8000b_3)}}$$

The variance of a linear combination of variables, say X and Y, is given by:

$$VAR(aX + bY) = a^2VAR(X) + b^2VAR(Y) + 2abCOV(X,Y)$$

(15 + 15 = 30 marks)

**TOTAL MARKS AVAILABLE (FOUR QUESTIONS) = 100**

## Formula Sheet - Networks

$t_{ij}$ = expected time

$\sigma_{ij}^2$ = variance

$OT_{ij}$ = most optimistic time

$\sigma_t$ = standard deviation

$PT_{ij}$ = most pessimistic time

$MT_{ij}$ = most likely time

$ET_j$ = earliest time at node j

$LT_i$ = latest time at node i

$TS_{ij}$ = total slack for activity i, j

$FS_{ij}$ = free slack for activity i, j

$ET_j = \text{Max}\,[\,ET_i + t_{ij}\,]$

$LT_i = \text{Min}\,[\,LT_j - t_{ij}\,]$

$TS_{ij} = LT_j - ET_i - t_{ij}$

$FS_{ij} = ET_j - ET_i - t_{ij}$

$$t_{ij} = \frac{OT_{ij} + 4MT_{ij} + PT_{ij}}{6}$$

$$\sigma_{ij}^2 = \left(\frac{PT_{ij} - OT_{ij}}{6}\right)^2$$

$$Z = \frac{X(t) - E(t)}{\sigma_t}$$

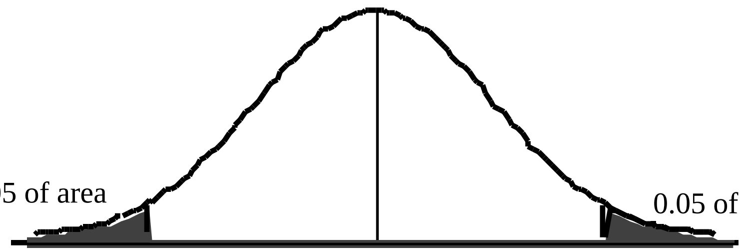
$$\sigma_t = \sqrt{\Sigma\sigma_{ij}^2}$$

$$\text{Per Unit Crash Cost} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal time} - \text{Crash time}}$$

### Areas under the Standard Normal Probability Distribution

| Z | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.07 | 0.08 | 0.09 |
|---|---|---|---|---|---|---|---|---|---|---|
| **0.0** | 0.0000 | 0.0040 | 0.0080 | 0.0120 | 0.0160 | 0.0199 | 0.0239 | 0.0279 | 0.0319 | 0.0359 |
| **0.1** | 0.0398 | 0.0438 | 0.0478 | 0.0517 | 0.0557 | 0.0596 | 0.0636 | 0.0675 | 0.0714 | 0.0753 |
| **0.2** | 0.0793 | 0.0832 | 0.0871 | 0.0910 | 0.0948 | 0.0987 | 0.1026 | 0.1064 | 0.1103 | 0.1141 |
| **0.3** | 0.1179 | 0.1217 | 0.1255 | 0.1293 | 0.1331 | 0.1368 | 0.1406 | 0.1443 | 0.1480 | 0.1517 |
| **0.4** | 0.1554 | 0.1591 | 0.1628 | 0.1664 | 0.1700 | 0.1736 | 0.1772 | 0.1808 | 0.1844 | 0.1879 |
| **0.5** | 0.1915 | 0.1950 | 0.1985 | 0.2019 | 0.2054 | 0.2088 | 0.2123 | 0.2157 | 0.2190 | 0.2224 |
| **0.6** | 0.2257 | 0.2291 | 0.2324 | 0.2357 | 0.2389 | 0.2422 | 0.2454 | 0.2486 | 0.2517 | 0.2549 |
| **0.7** | 0.2580 | 0.2611 | 0.2642 | 0.2673 | 0.2704 | 0.2734 | 0.2764 | 0.2794 | 0.2823 | 0.2852 |
| **0.8** | 0.2881 | 0.2910 | 0.2939 | 0.2967 | 0.2995 | 0.3023 | 0.3051 | 0.3078 | 0.3106 | 0.3133 |
| **0.9** | 0.3159 | 0.3186 | 0.3212 | 0.3238 | 0.3264 | 0.3289 | 0.3315 | 0.3340 | 0.3365 | 0.3389 |
| **1.0** | 0.3413 | 0.3438 | 0.3461 | 0.3485 | 0.3508 | 0.3531 | 0.3554 | 0.3577 | 0.3599 | 0.3621 |
| **1.1** | 0.3643 | 0.3665 | 0.3686 | 0.3708 | 0.3729 | 0.3749 | 0.3770 | 0.3790 | 0.3810 | 0.3830 |
| **1.2** | 0.3849 | 0.3869 | 0.3888 | 0.3907 | 0.3925 | 0.3944 | 0.3962 | 0.3980 | 0.3997 | 0.4015 |
| **1.3** | 0.4032 | 0.4049 | 0.4066 | 0.4082 | 0.4099 | 0.4115 | 0.4131 | 0.4147 | 0.4162 | 0.4177 |
| **1.4** | 0.4192 | 0.4207 | 0.4222 | 0.4236 | 0.4251 | 0.4265 | 0.4279 | 0.4292 | 0.4306 | 0.4319 |
| **1.5** | 0.4332 | 0.4345 | 0.4357 | 0.4370 | 0.4382 | 0.4394 | 0.4406 | 0.4418 | 0.4429 | 0.4441 |
| **1.6** | 0.4452 | 0.4463 | 0.4474 | 0.4484 | 0.4495 | 0.4505 | 0.4515 | 0.4525 | 0.4535 | 0.4545 |
| **1.7** | 0.4554 | 0.4564 | 0.4573 | 0.4582 | 0.4591 | 0.4599 | 0.4608 | 0.4616 | 0.4625 | 0.4633 |
| **1.8** | 0.4641 | 0.4649 | 0.4656 | 0.4664 | 0.4671 | 0.4678 | 0.4686 | 0.4693 | 0.4699 | 0.4706 |
| **1.9** | 0.4713 | 0.4719 | 0.4726 | 0.4732 | 0.4738 | 0.4744 | 0.4750 | 0.4756 | 0.4761 | 0.4767 |
| **2.0** | 0.4772 | 0.4778 | 0.4783 | 0.4788 | 0.4793 | 0.4798 | 0.4803 | 0.4808 | 0.4812 | 0.4817 |
| **2.1** | 0.4821 | 0.4826 | 0.4830 | 0.4834 | 0.4838 | 0.4842 | 0.4846 | 0.4850 | 0.4854 | 0.4857 |
| **2.2** | 0.4861 | 0.4864 | 0.4868 | 0.4871 | 0.4875 | 0.4878 | 0.4881 | 0.4884 | 0.4887 | 0.4890 |
| **2.3** | 0.4893 | 0.4896 | 0.4898 | 0.4901 | 0.4904 | 0.4906 | 0.4909 | 0.4911 | 0.4913 | 0.4916 |
| **2.4** | 0.4918 | 0.4920 | 0.4922 | 0.4925 | 0.4927 | 0.4929 | 0.4931 | 0.4932 | 0.4934 | 0.4936 |
| **2.5** | 0.4938 | 0.4940 | 0.4941 | 0.4943 | 0.4945 | 0.4946 | 0.4948 | 0.4949 | 0.4951 | 0.4952 |
| **2.6** | 0.4953 | 0.4955 | 0.4956 | 0.4957 | 0.4959 | 0.4960 | 0.4961 | 0.4962 | 0.4963 | 0.4964 |
| **2.7** | 0.4965 | 0.4966 | 0.4967 | 0.4968 | 0.4969 | 0.4970 | 0.4971 | 0.4972 | 0.4973 | 0.4974 |
| **2.8** | 0.4974 | 0.4975 | 0.4976 | 0.4977 | 0.4977 | 0.4978 | 0.4979 | 0.4979 | 0.4980 | 0.4981 |
| **2.9** | 0.4981 | 0.4982 | 0.4982 | 0.4983 | 0.4984 | 0.4984 | 0.4985 | 0.4985 | 0.4986 | 0.4986 |
| **3.0** | 0.4987 | 0.4987 | 0.4987 | 0.4988 | 0.4988 | 0.4989 | 0.4989 | 0.4989 | 0.4990 | 0.4990 |

Areas in both tails combined for the **Student's t Distribution**




=TINV(probability, df)

| Degrees of freedom | **0.10** | **0.05** | **0.02** | **0.01** |
|---|---|---|---|---|
| 1 | 6.3137 | 12.7062 | 31.8210 | 63.6559 |
| 2 | 2.9200 | 4.3027 | 6.9645 | 9.9250 |
| 3 | 2.3534 | 3.1824 | 4.5407 | 5.8408 |
| 4 | 2.1318 | 2.7765 | 3.7469 | 4.6041 |
| 5 | 2.0150 | 2.5706 | 3.3649 | 4.0321 |
| 6 | 1.9432 | 2.4469 | 3.1427 | 3.7074 |
| 7 | 1.8946 | 2.3646 | 2.9979 | 3.4995 |
| 8 | 1.8595 | 2.3060 | 2.8965 | 3.3554 |
| 9 | 1.8331 | 2.2622 | 2.8214 | 3.2498 |
| 10 | 1.8125 | 2.2281 | 2.7638 | 3.1693 |
| 11 | 1.7959 | 2.2010 | 2.7181 | 3.1058 |
| 12 | 1.7823 | 2.1788 | 2.6810 | 3.0545 |
| 13 | 1.7709 | 2.1604 | 2.6503 | 3.0123 |
| 14 | 1.7613 | 2.1448 | 2.6245 | 2.9768 |
| 15 | 1.7531 | 2.1315 | 2.6025 | 2.9467 |
| 16 | 1.7459 | 2.1199 | 2.5835 | 2.9208 |
| 17 | 1.7396 | 2.1098 | 2.5669 | 2.8982 |
| 18 | 1.7341 | 2.1009 | 2.5524 | 2.8784 |
| 19 | 1.7291 | 2.0930 | 2.5395 | 2.8609 |
| 20 | 1.7247 | 2.0860 | 2.5280 | 2.8453 |
| 21 | 1.7207 | 2.0796 | 2.5176 | 2.8314 |
| 22 | 1.7171 | 2.0739 | 2.5083 | 2.8188 |
| 23 | 1.7139 | 2.0687 | 2.4999 | 2.8073 |
| 24 | 1.7109 | 2.0639 | 2.4922 | 2.7970 |
| 25 | 1.7081 | 2.0595 | 2.4851 | 2.7874 |
| 26 | 1.7056 | 2.0555 | 2.4786 | 2.7787 |
| 27 | 1.7033 | 2.0518 | 2.4727 | 2.7707 |
| 28 | 1.7011 | 2.0484 | 2.4671 | 2.7633 |
| 29 | 1.6991 | 2.0452 | 2.4620 | 2.7564 |
| 30 | 1.6973 | 2.0423 | 2.4573 | 2.7500 |
| 40 | 1.6839 | 2.0211 | 2.4233 | 2.7045 |
| 50 | 1.6759 | 2.0086 | 2.4033 | 2.6778 |
| 60 | 1.6706 | 2.0003 | 2.3901 | 2.6603 |
| 70 | 1.6669 | 1.9944 | 2.3808 | 2.6479 |
| 80 | 1.6641 | 1.9901 | 2.3739 | 2.6387 |
| 90 | 1.6620 | 1.9867 | 2.3685 | 2.6316 |
| 100 | 1.6602 | 1.9840 | 2.3642 | 2.6259 |
| 110 | 1.6588 | 1.9818 | 2.3607 | 2.6213 |
| 120 | 1.6576 | 1.9799 | 2.3578 | 2.6174 |
| 130 | 1.6567 | 1.9784 | 2.3554 | 2.6142 |
| 150 | 1.6551 | 1.9759 | 2.3515 | 2.6090 |
| 200 | 1.6525 | 1.9719 | 2.3451 | 2.6006 |
| 300 | 1.6499 | 1.9679 | 2.3388 | 2.5923 |
| 500 | 1.6479 | 1.9647 | 2.3338 | 2.5857 |
| 999 | 1.6464 | 1.9623 | 2.3301 | 2.5808 |

**Table 3B:** Values for the *F* Distribution with **0.01** of the area in the right tail

| | Degrees of freedom for the numerator | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **df** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **12** | **15** | **20** | **24** | **30** | **40** | **60** | **120** |
| **1** | 4052 | 4999 | 5403 | 5624 | 5764 | 5859 | 5928 | 5981 | 6022 | 6056 | 6106 | 6157 | 6208 | 6234 | 6260 | 6286 | 6313 | 6339 |
| **2** | 98.50 | 99.00 | 99.16 | 99.25 | 99.30 | 99.33 | 99.36 | 99.38 | 99.39 | 99.40 | 99.42 | 99.43 | 99.45 | 99.46 | 99.47 | 99.48 | 99.48 | 99.49 |
| **3** | 34.12 | 30.82 | 29.46 | 28.71 | 28.24 | 27.91 | 27.67 | 27.49 | 27.34 | 27.23 | 27.05 | 26.87 | 26.69 | 26.60 | 26.50 | 26.41 | 26.32 | 26.22 |
| **4** | 21.20 | 18.00 | 16.69 | 15.98 | 15.52 | 15.21 | 14.98 | 14.80 | 14.66 | 14.55 | 14.37 | 14.20 | 14.02 | 13.93 | 13.84 | 13.75 | 13.65 | 13.56 |
| **5** | 16.26 | 13.27 | 12.06 | 11.39 | 10.97 | 10.67 | 10.46 | 10.29 | 10.16 | 10.05 | 9.89 | 9.72 | 9.55 | 9.47 | 9.38 | 9.29 | 9.20 | 9.11 |
| **6** | 13.75 | 10.92 | 9.78 | 9.15 | 8.75 | 8.47 | 8.26 | 8.10 | 7.98 | 7.87 | 7.72 | 7.56 | 7.40 | 7.31 | 7.23 | 7.14 | 7.06 | 6.97 |
| **7** | 12.25 | 9.55 | 8.45 | 7.85 | 7.46 | 7.19 | 6.99 | 6.84 | 6.72 | 6.62 | 6.47 | 6.31 | 6.16 | 6.07 | 5.99 | 5.91 | 5.82 | 5.74 |
| **8** | 11.26 | 8.65 | 7.59 | 7.01 | 6.63 | 6.37 | 6.18 | 6.03 | 5.91 | 5.81 | 5.67 | 5.52 | 5.36 | 5.28 | 5.20 | 5.12 | 5.03 | 4.95 |
| **9** | 10.56 | 8.02 | 6.99 | 6.42 | 6.06 | 5.80 | 5.61 | 5.47 | 5.35 | 5.26 | 5.11 | 4.96 | 4.81 | 4.73 | 4.65 | 4.57 | 4.48 | 4.40 |
| **10** | 10.04 | 7.56 | 6.55 | 5.99 | 5.64 | 5.39 | 5.20 | 5.06 | 4.94 | 4.85 | 4.71 | 4.56 | 4.41 | 4.33 | 4.25 | 4.17 | 4.08 | 4.00 |
| **11** | 9.65 | 7.21 | 6.22 | 5.67 | 5.32 | 5.07 | 4.89 | 4.74 | 4.63 | 4.54 | 4.40 | 4.25 | 4.10 | 4.02 | 3.94 | 3.86 | 3.78 | 3.69 |
| **12** | 9.33 | 6.93 | 5.95 | 5.41 | 5.06 | 4.82 | 4.64 | 4.50 | 4.39 | 4.30 | 4.16 | 4.01 | 3.86 | 3.78 | 3.70 | 3.62 | 3.54 | 3.45 |
| **13** | 9.07 | 6.70 | 5.74 | 5.21 | 4.86 | 4.62 | 4.44 | 4.30 | 4.19 | 4.10 | 3.96 | 3.82 | 3.66 | 3.59 | 3.51 | 3.43 | 3.34 | 3.25 |
| **14** | 8.86 | 6.51 | 5.56 | 5.04 | 4.69 | 4.46 | 4.28 | 4.14 | 4.03 | 3.94 | 3.80 | 3.66 | 3.51 | 3.43 | 3.35 | 3.27 | 3.18 | 3.09 |
| **15** | 8.68 | 6.36 | 5.42 | 4.89 | 4.56 | 4.32 | 4.14 | 4.00 | 3.89 | 3.80 | 3.67 | 3.52 | 3.37 | 3.29 | 3.21 | 3.13 | 3.05 | 2.96 |
| **16** | 8.53 | 6.23 | 5.29 | 4.77 | 4.44 | 4.20 | 4.03 | 3.89 | 3.78 | 3.69 | 3.55 | 3.41 | 3.26 | 3.18 | 3.10 | 3.02 | 2.93 | 2.84 |
| **17** | 8.40 | 6.11 | 5.19 | 4.67 | 4.34 | 4.10 | 3.93 | 3.79 | 3.68 | 3.59 | 3.46 | 3.31 | 3.16 | 3.08 | 3.00 | 2.92 | 2.83 | 2.75 |
| **18** | 8.29 | 6.01 | 5.09 | 4.58 | 4.25 | 4.01 | 3.84 | 3.71 | 3.60 | 3.51 | 3.37 | 3.23 | 3.08 | 3.00 | 2.92 | 2.84 | 2.75 | 2.66 |
| **19** | 8.18 | 5.93 | 5.01 | 4.50 | 4.17 | 3.94 | 3.77 | 3.63 | 3.52 | 3.43 | 3.30 | 3.15 | 3.00 | 2.92 | 2.84 | 2.76 | 2.67 | 2.58 |
| **20** | 8.10 | 5.85 | 4.94 | 4.43 | 4.10 | 3.87 | 3.70 | 3.56 | 3.46 | 3.37 | 3.23 | 3.09 | 2.94 | 2.86 | 2.78 | 2.69 | 2.61 | 2.52 |
| **21** | 8.02 | 5.78 | 4.87 | 4.37 | 4.04 | 3.81 | 3.64 | 3.51 | 3.40 | 3.31 | 3.17 | 3.03 | 2.88 | 2.80 | 2.72 | 2.64 | 2.55 | 2.46 |
| **22** | 7.95 | 5.72 | 4.82 | 4.31 | 3.99 | 3.76 | 3.59 | 3.45 | 3.35 | 3.26 | 3.12 | 2.98 | 2.83 | 2.75 | 2.67 | 2.58 | 2.50 | 2.40 |
| **23** | 7.88 | 5.66 | 4.76 | 4.26 | 3.94 | 3.71 | 3.54 | 3.41 | 3.30 | 3.21 | 3.07 | 2.93 | 2.78 | 2.70 | 2.62 | 2.54 | 2.45 | 2.35 |
| **24** | 7.82 | 5.61 | 4.72 | 4.22 | 3.90 | 3.67 | 3.50 | 3.36 | 3.26 | 3.17 | 3.03 | 2.89 | 2.74 | 2.66 | 2.58 | 2.49 | 2.40 | 2.31 |
| **25** | 7.77 | 5.57 | 4.68 | 4.18 | 3.85 | 3.63 | 3.46 | 3.32 | 3.22 | 3.13 | 2.99 | 2.85 | 2.70 | 2.62 | 2.54 | 2.45 | 2.36 | 2.27 |
| **26** | 7.72 | 5.53 | 4.64 | 4.14 | 3.82 | 3.59 | 3.42 | 3.29 | 3.18 | 3.09 | 2.96 | 2.81 | 2.66 | 2.58 | 2.50 | 2.42 | 2.33 | 2.23 |
| **27** | 7.68 | 5.49 | 4.60 | 4.11 | 3.78 | 3.56 | 3.39 | 3.26 | 3.15 | 3.06 | 2.93 | 2.78 | 2.63 | 2.55 | 2.47 | 2.38 | 2.29 | 2.20 |
| **28** | 7.64 | 5.45 | 4.57 | 4.07 | 3.75 | 3.53 | 3.36 | 3.23 | 3.12 | 3.03 | 2.90 | 2.75 | 2.60 | 2.52 | 2.44 | 2.35 | 2.26 | 2.17 |
| **29** | 7.60 | 5.42 | 4.54 | 4.04 | 3.73 | 3.50 | 3.33 | 3.20 | 3.09 | 3.00 | 2.87 | 2.73 | 2.57 | 2.49 | 2.41 | 2.33 | 2.23 | 2.14 |
| **30** | 7.56 | 5.39 | 4.51 | 4.02 | 3.70 | 3.47 | 3.30 | 3.17 | 3.07 | 2.98 | 2.84 | 2.70 | 2.55 | 2.47 | 2.39 | 2.30 | 2.21 | 2.11 |
| **40** | 7.31 | 5.18 | 4.31 | 3.83 | 3.51 | 3.29 | 3.12 | 2.99 | 2.89 | 2.80 | 2.66 | 2.52 | 2.37 | 2.29 | 2.20 | 2.11 | 2.02 | 1.92 |
| **50** | 7.17 | 5.06 | 4.20 | 3.72 | 3.41 | 3.19 | 3.02 | 2.89 | 2.78 | 2.70 | 2.56 | 2.42 | 2.27 | 2.18 | 2.10 | 2.01 | 1.91 | 1.80 |
| **60** | 7.08 | 4.98 | 4.13 | 3.65 | 3.34 | 3.12 | 2.95 | 2.82 | 2.72 | 2.63 | 2.50 | 2.35 | 2.20 | 2.12 | 2.03 | 1.94 | 1.84 | 1.73 |
| **80** | 6.96 | 4.88 | 4.04 | 3.56 | 3.26 | 3.04 | 2.87 | 2.74 | 2.64 | 2.55 | 2.42 | 2.27 | 2.12 | 2.03 | 1.94 | 1.85 | 1.75 | 1.63 |
| **100** | 6.90 | 4.82 | 3.98 | 3.51 | 3.21 | 2.99 | 2.82 | 2.69 | 2.59 | 2.50 | 2.37 | 2.22 | 2.07 | 1.98 | 1.89 | 1.80 | 1.69 | 1.57 |
| **120** | 6.85 | 4.79 | 3.95 | 3.48 | 3.17 | 2.96 | 2.79 | 2.66 | 2.56 | 2.47 | 2.34 | 2.19 | 2.03 | 1.95 | 1.86 | 1.76 | 1.66 | 1.53 |
| **1000** | 6.66 | 4.63 | 3.80 | 3.34 | 3.04 | 2.82 | 2.66 | 2.53 | 2.43 | 2.34 | 2.20 | 2.06 | 1.90 | 1.81 | 1.72 | 1.61 | 1.50 | 1.35 |

# PR220 End of year examination 1999

## Time Allowed: **2 hours**

**The exam paper consists of two parts as follows:**

**Part A: All students must attempt this part of the paper**

Part A of the paper will be marked out of 100% of the marks available for this part of the examination paper.

Students who achieve at least 50%, but less than 60%, of the available marks for Part A will be awarded a pass (PA).

Students who achieve at least 60% of the available marks for Part A will be awarded a credit (CR).

**The award of credit (CR) is the highest mark available for Part A.**

| | | |
|---|---|---|
| **Question 1:** | Multivariate analysis<br>Principal Components and Factor Analysis | Marks = 20 |
| **Question 2:** | Time Series Forecasting | Marks = 20 |
| **Question 3:** | Network Analysis | Marks = 30 |

**Part B: This section of the paper is optional**

To be eligible to receive the award of **Distinction** or above, students must complete this section of the examination paper.

This section of the examination paper is based on the work completed during the special classes held during second semester.

| | | |
|---|---|---|
| **Question 4:** | Modelling property data | Marks = 30 |