RMIT UNIVERSITY

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EXAM COVER SHEET

NOTE: DO NOT REMOVE this exam paper from the exam venue

EXAM DETAILS

Course Code: **MATH1318**

Course Description: **Time Series Analysis**

Date of exam: 9/06/2010 **Start time of exam:** 17:45 PM **Duration of exam:** 2hr 15min

Total number of pages (incl. this cover sheet) 9

ALLOWABLE MATERIALS AND INSTRUCTIONS TO CANDIDATES

1. Write your full name and student number on each exam booklet together with the number of exam books used.
2. Students must not write, mark in any way any exam materials, read any other text other than the exam paper or do any calculations during reading time.
3. All mobile phones must be switched off and placed under your desk. You are in breach of exam conditions if it is on your person (ie. pocket).
4. This is an **OPEN BOOK** Exam.
5. Commence each question on a new page. Carry out the instructions on the front cover of the exam script book and the front of this exam paper.
6. Non text storing calculators are allowed.
7. Electronic dictionaries are allowed.
8. Candidates should answer all three (3) questions.
9. All questions are of equal value, 17 marks each. This paper is worth 50 marks. Work completed during the semester is worth 50 marks (30 marks for the assignments and 20 marks for the project).

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1. Four time series have been selected. Their time series plots are given in Attachment A (plots A to D). Their autocorrelation and partial autocorrelation functions are plotted in Attachment B (plots a to d). Periodograms are plotted in Attachment C (plots α, β, γ and δ).

   Explain the features in each plot.

   Hence identify which ACF/PACF and which spectrum goes with each time series plot.

   (17 marks)

2. The following questions relate to ARMA processes.

   (a) Determine whether the process $\{X_t = \rho^2 X_{t-2} + Z_t, t = 0,\pm1,\pm2,\cdots\}$ is stationary by finding EX_t and $\text{cov}(X_t, X_{t+h})$. $\{Z_t, t = 0,\pm1,\pm2,\cdots\}$ is an $IID(0,1)$ sequence in each case.

   (b) Consider the ARMA(3,2) process defined by

   $$X_t - 0.729X_{t-3} = Z_t - 0.40Z_{t-1} + 0.80Z_{t-2},\ t = 0,\pm1,\pm2,\cdots \text{ where } Z_t \sim WN(0,1).$$

   (i) Explain the concept of invertibility. Is this process invertible?

   (ii) Explain the concept of causality. Is this process causal?

   (iii) Derive and sketch the spectrum of X_t.

   (6 + (4 + 4 + 3)) = 17 marks)

3. We wish to study the relationship between the Indonesian Rupiah and the Malaysian Ringgit. Daily values of these currencies per $1 Australian have been averaged for each month from December 1998 to May 2010 (138 observations). These data are shown in figure 1 with the data differenced at lag 1 in figures 2 & 3 below.

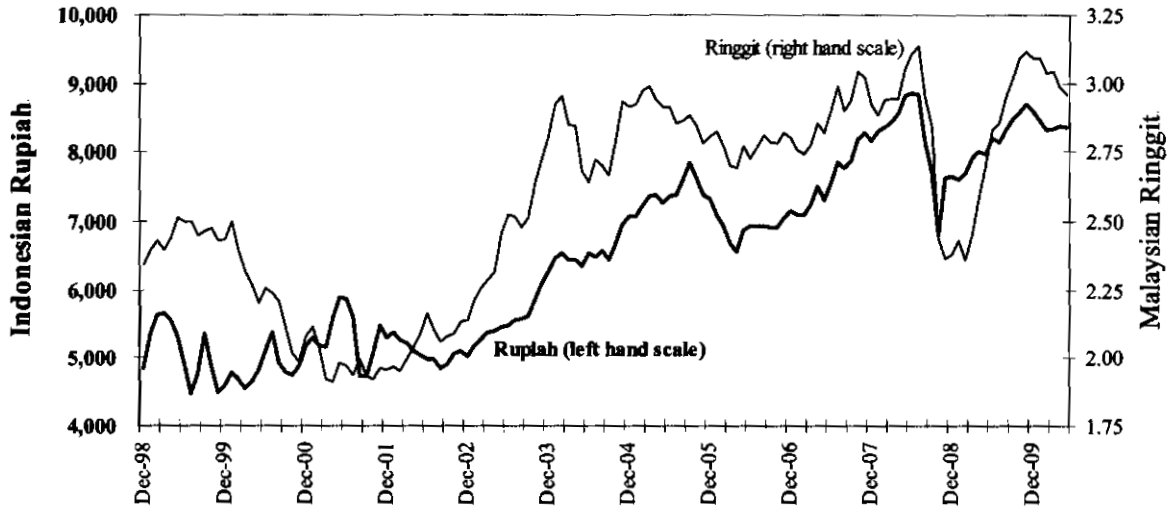


Figure 1 Indonesian Rupiah (left hand scale) and Malaysian Ringgit (right hand scale) = $1 Aus

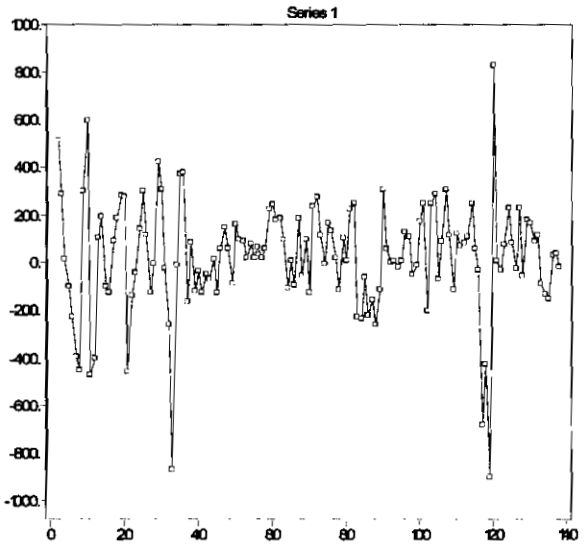


Figure 2 Differences at lag 1 of the Rupiah

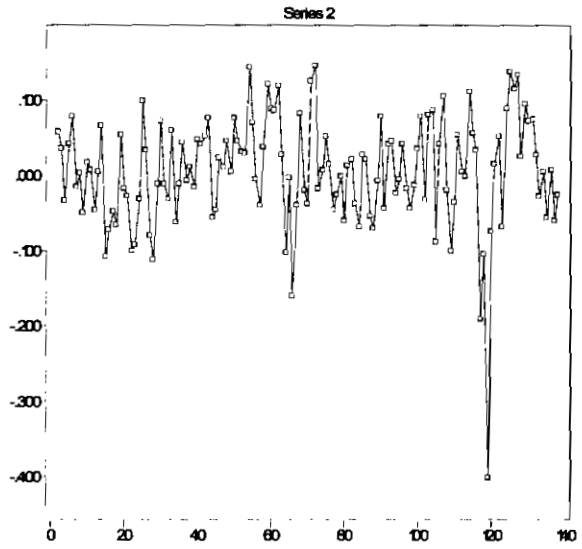


Figure 3 Differences at lag 1 of the Ringgit

/Q3 continued

Question 3. Continued

The cross correlation function between the two differenced series is

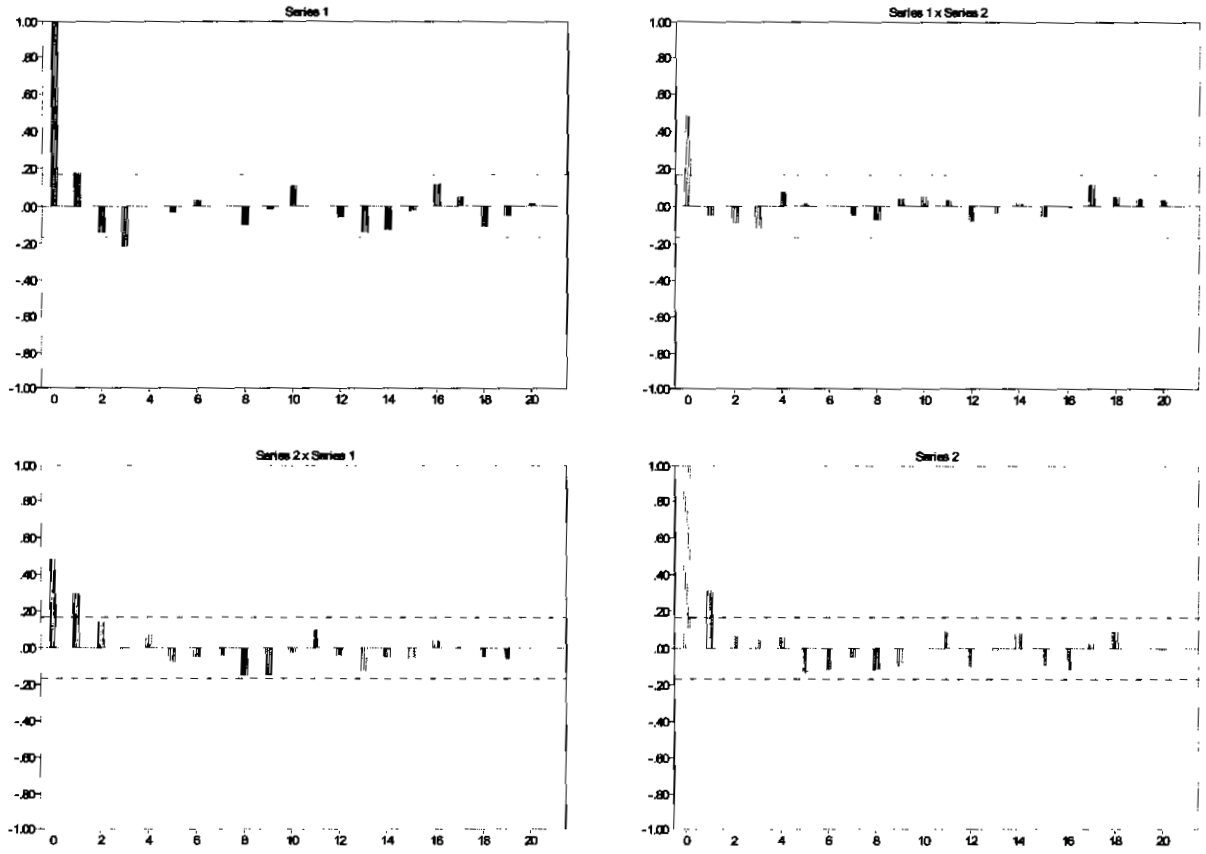


Figure 4 Cross-correlations between the Rupiah and Ringgit both differenced at lag 1.

(a) Describe the variables and their relationships by commenting on each graph.

(b) Is there any evidence that one variable leads the other? (Support your answer.)

(c) The data were modelled using the multivariate Burg algorithm in ITSM - an extract of the results is shown in Attachment D. Describe briefly what was done at each step (and why) and select the better of the two models presented and write it in summary form. Do the coefficients appear to confirm the conclusion you made in (b)?

(d) Suppose the objective is to forecast the next two months. Describe any modifications that you consider should be made to the estimation procedure carried out so far (if any). Produce 95% interval estimates for the Indonesian Rupiah for the next 2 months.

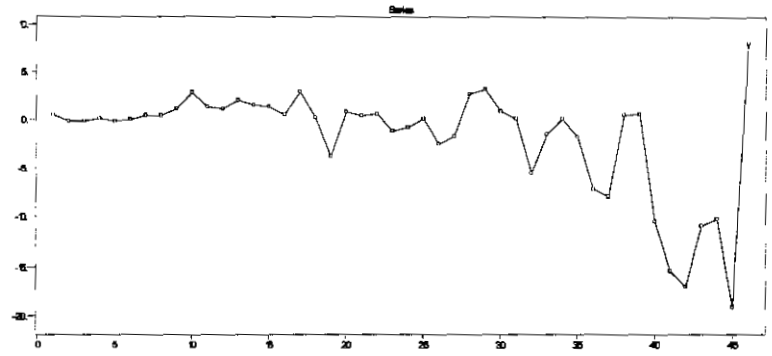
(e) The spectra for each series and the cross spectra were smoothed using the window shown in Attachment E. At what frequency do the two major peaks occur for the Malaysian Ringgit and what time periods do those frequencies represent?

(4 + 2 + 6 + 3 + 2 = 17 marks)

Attachment A

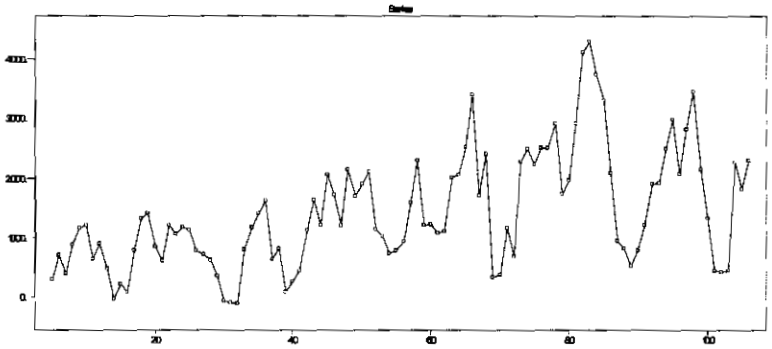
A

Annual Australian Balance of payments ($m). Data from 1963-4 to 2008-9



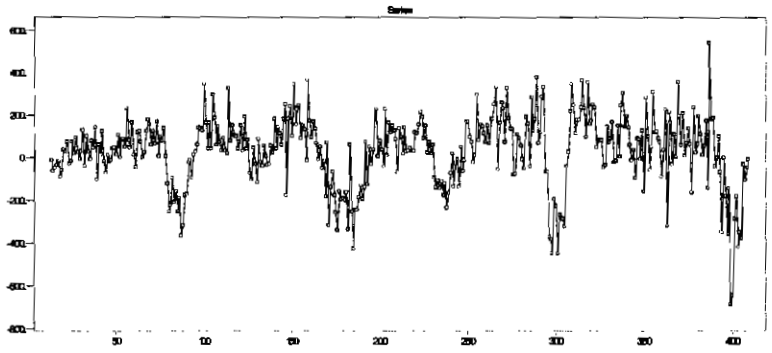
B

Quarterly retail turnover, Chain volume measures (reference year 2007-8), ($m), Differenced at lag 4. Data from December 1993 to December 2009



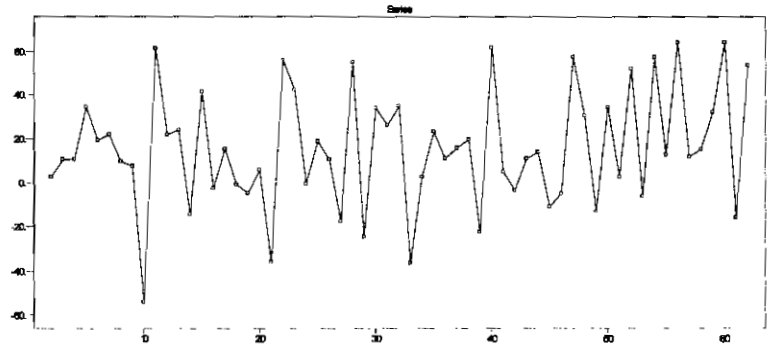
C

Monthly production of pre-mixed concrete n Australia ('000 cu.m.) differenced at lag 12. Data from February 1977 to February 2010



D

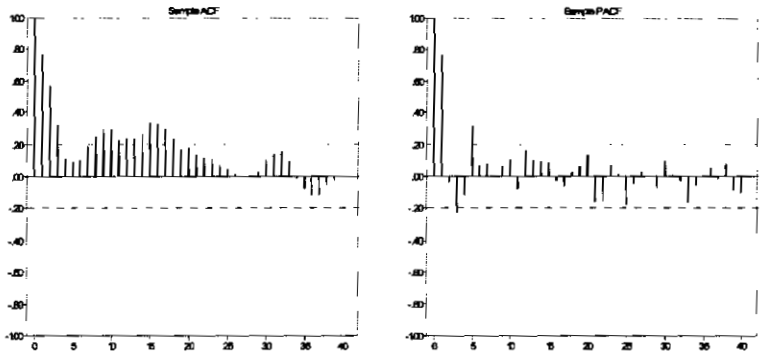
Quarterly Average weekly earnings in the Australian Mining Industry, ($) differenced at lag 1. Data from November 1995 to November 2009



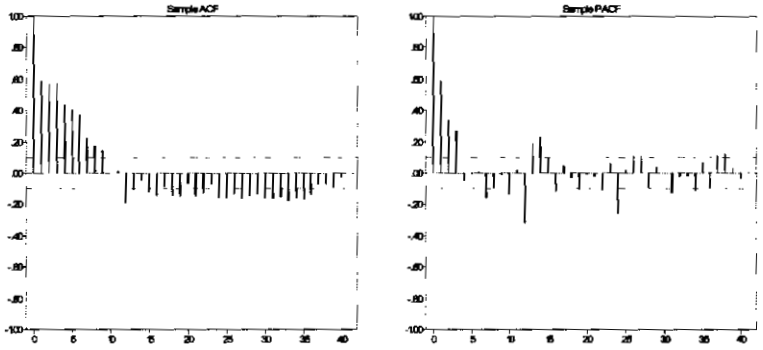
Attachment B

ACF/PACF Plots

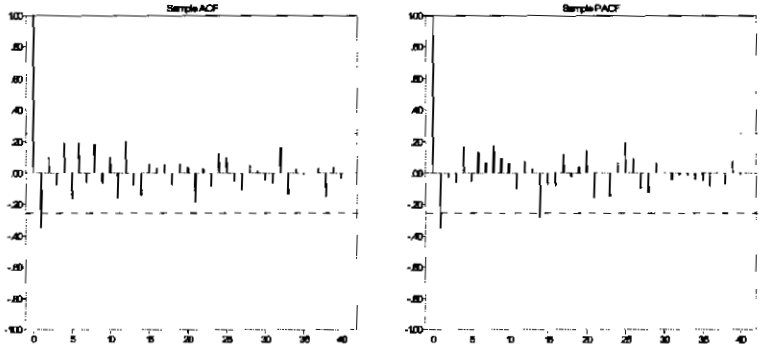
a



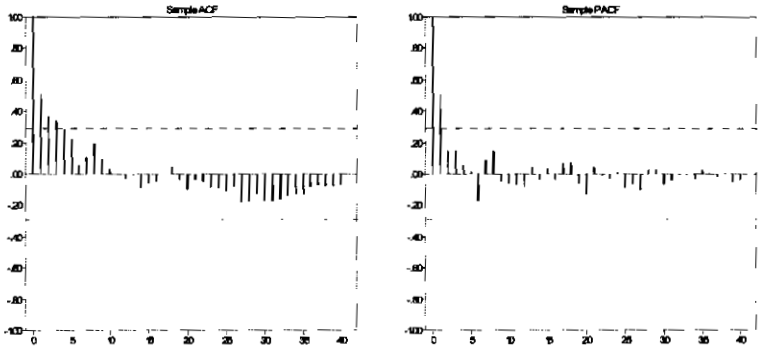
b



c

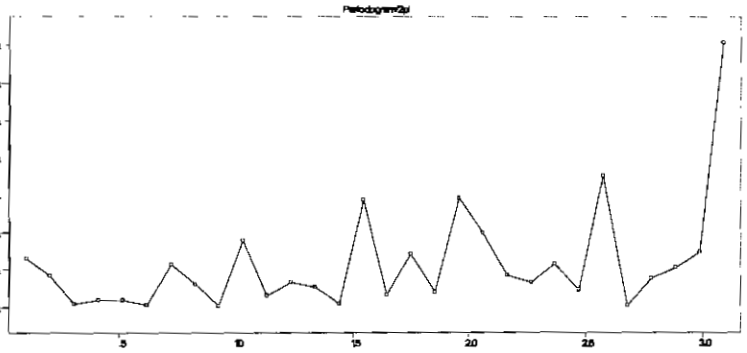


d

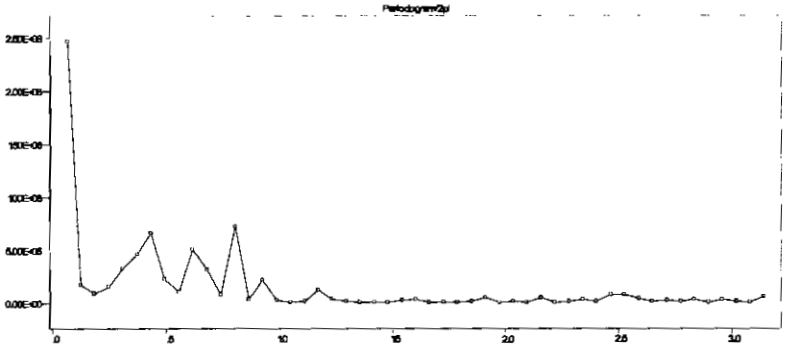


Attachment C

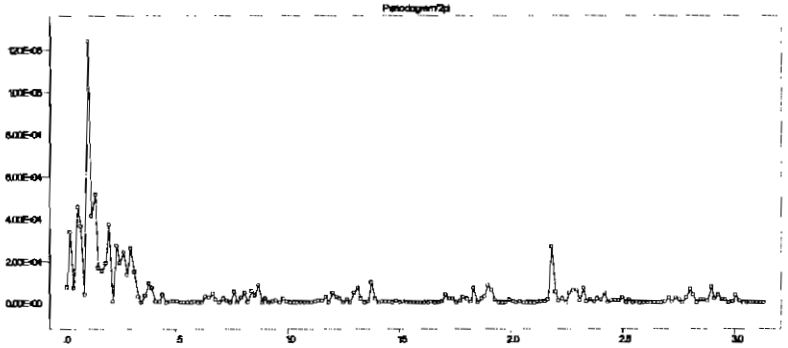
α



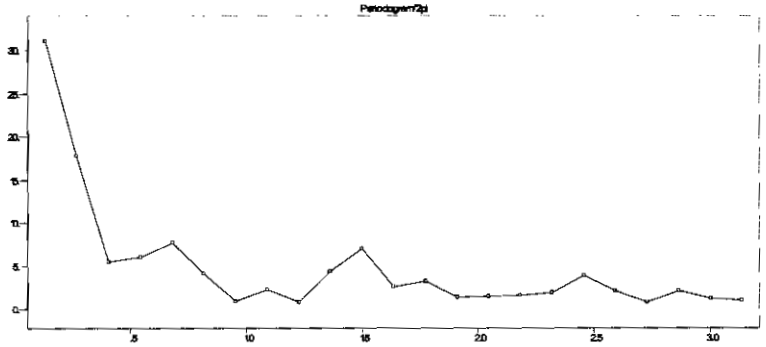
β



γ



δ



Attachment D

Output from ITSM – Multivariate Burg

Series 1 contains values of the Indonesian Rupiah per $1Aus and
Series 2 contains values of the Malaysian Ringgit per $1Aus.

ITSM::(Multivariate Burg Estimates)

Optimal value of p = 1

```
PHI(0)
  21.485959
    .001993

PHI(1)
    .268882  -.595813E+03
    .000057       .229930

Burg White Noise Covariance
Matrix, V
.525109E+05      7.871614
   7.871614       .004551
```

AICC = .149695E+04

ITSM::(Multivariate AR Forecasts)

Series 1

Time	Prediction	sqrt(MSE)
139	.83997E+04	.22915E+03
140	.84325E+04	.35605E+03
141	.84612E+04	.44913E+03
142	.84877E+04	.52416E+03
143	.85136E+04	.58883E+03
144	.85393E+04	.64681E+03
145	.85650E+04	.69996E+03
146	.85907E+04	.74934E+03

Series 2

Time	Prediction	sqrt(MSE)
139	2.95329	.06746
140	2.95602	.11279
141	2.96053	.14798
142	2.96521	.17654
143	2.96980	.20095
144	2.97434	.22261
145	2.97885	.24232
146	2.98335	.26053

p = 2

```
 PHI(0)
  24.259232
    .001763
PHI(1)
    .291912  -.517614E+03
    .000055       .226119
PHI(2)
   -.175572   .176839E+03
    .000017      -.025433
Burg White Noise Covariance
Matrix, V
   .512318E+05      7.991933
     7.991933       .004540
```

AICC = .149881E+04

ITSM::(Multivariate AR Forecasts)

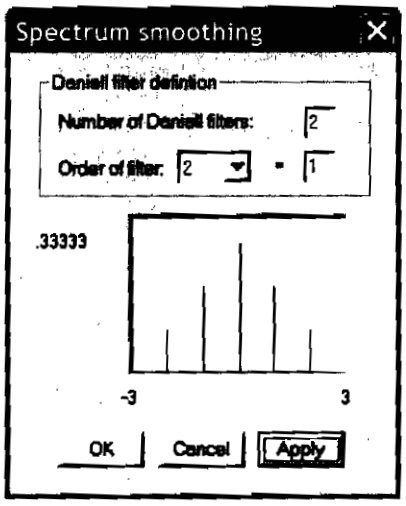
Series 1

Time	Prediction	sqrt(MSE)
139	.83828E+04	.22634E+03
140	.84114E+04	.35675E+03
141	.84397E+04	.43366E+03
142	.84654E+04	.48952E+03
143	.84906E+04	.53992E+03
144	.85161E+04	.58781E+03
145	.85419E+04	.63256E+03
146	.85677E+04	.67413E+03

Series 2

Time	Prediction	sqrt(MSE)
139	2.95537	.06738
140	2.95770	.11218
141	2.96187	.14779
142	2.96655	.17625
143	2.97115	.20020
144	2.97564	.22147
145	2.98012	.24095
146	2.98462	.25901

Attachment E



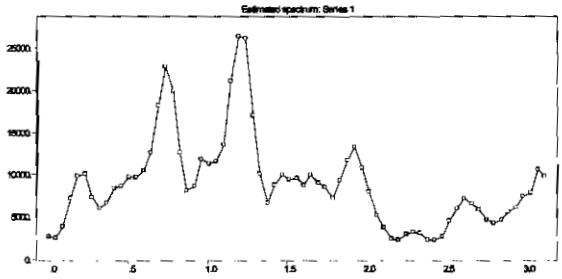
ITSM::Multivariate(Spectrum)

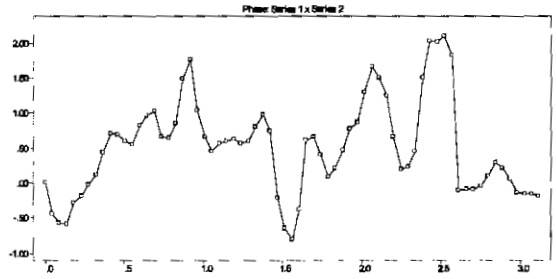
Number of frequencies in periodogram = 70

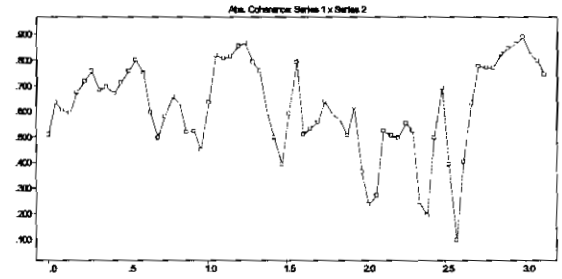
Fundamental Fourier frequency 2*pi/n = .045863

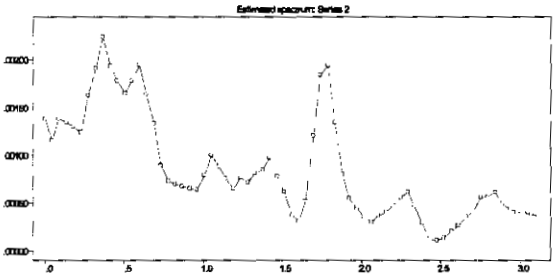
Smoothing coefficients:
W[0] = .33333
W[1] = .22222
W[2] = .11111

Smooth coefficient sum of squares = .23457









End of Examination Paper