Learning Guide
Table of Contents

SECTION 1: ABOUT TIME SERIES AND FORECASTING
   An introduction to this unit 1
   Approach to teaching 1
   Staff details 1
   Student consultation arrangements 2
   Student feedback and improvements to the unit 2

SECTION 2: YOU AND THIS UNIT
   What is expected of you 3
   What you can expect from me 4
   How to use this learning guide 4
   Policy and how it affects you 5
   What to do if you have a problem/concern 7

SECTION 3: TEACHING AND LEARNING ACTIVITIES
   Schedule of teaching and learning activities 8

SECTION 4: ASSESSMENT INFORMATION
   Learning outcomes and assessment 10
   Assessment details 11
   Sample questions and marking schemes 14

SECTION 5: LEARNING RESOURCES AND INFORMATION
   Overview of learning resources 17
   People who can help 17
   Useful reading 18
   Online resources 19
   UWS website – Current students 19
   Referencing requirements 19
About Time Series and Forecasting

1. An introduction to this unit

This level 300 unit covers time series and forecasting. It presents the basic techniques of time series analysis with emphasis on model identification, parameter estimation and diagnostic checking. The use of time series models for the process of forecasting future behaviour is discussed. In addition, alternative forecasting approaches, in particular econometric methods, are introduced and some guidelines for choosing an appropriate forecasting method are outlined.

Pre-requisites: 200033 Applied Statistics.

Co-requisites: N/A.

2. Approach to teaching

This unit enhances learning through the following means:

This unit consists of a two-hour lecture, and a two-hour computer lab session weekly. Students are expected to read the lecture notes or reading material before attending the lecture. Students need to attempt the set tutorial questions before attending the tutorials. Practicals will be supervised individual work.

Your lecturer and/or the teaching team will provide you with oral and written feedback on class test papers and assignments. To improve the teaching of the course, you are encouraged to voice your comments.

3. Staff details

Unit Coordinator: Dr Zhi Guo

Building ER, Room G.14, Parramatta Campus
Phone: (02) 9685 9283
Email: z.guo@uws.edu.au
4. **Student consultation arrangements**

Tue 11:00 – 13:00, Weeks 1 – 8, 10 – 14, or by appointment.

5. **Student feedback and improvements to the unit**

The University values student feedback in order to improve the quality of its educational programs. Comments can be sent to the lecturer and/or the teaching team.
You and this unit

6. What is expected of you

Unit credit points and Workload
This unit is a 10-credit point unit and will require your full and continuous attention to maintain the highest possible grades. It is expected that you will spend at least 10 hours each week (on average) which includes the four (4) contact hours per week. Some weeks you will spend more time on learning activities and assessments and in other weeks the workload will be somewhat less. It will be essential for you to keep up with the assigned reading so that you are properly prepared for each session.

Attendance
Students are expected to attend the 2-hour lecture each week and the 2-hour tutorial/practical.

Online learning
Students should access rUWS and check their student email account at least twice a week.

General conduct and behaviour
According to the UWS Teaching and Learning code (http://policies.uws.edu.au/view.current.php?id=00139) you are required to:

- obtain the unit outline for this unit, by the end of the second teaching week;
- regularly and actively participate in all scheduled educational activities, which includes lectures, tutorial, laboratory sessions, online activities etc;
- give honest, helpful and courteous feedback to your lecturer(s)
- make every effort to undertake the work required to successfully complete this unit;
- submit work that is your own for any assessment task;
- not indulge in any behaviour that disrupts the teaching and learning environment, or negatively affects fellow students and university staff, and understand that the University will take action against such behaviour as outlined in the Misconduct – Students Non-Academic Misconduct Policy
- treat university property with due care and report and damaged or broken equipment.

In addition, you should:

- be on time to lectures, tutorial and laboratory sessions. If you are late, then please enter the lecture/tutorial room or lab with courtesy and consideration for others;
- pay attention in lectures, tutorials and laboratory sessions as this is where helpful information is given out of the assessment tasks;
- switch off your mobile phone
• ask questions about the content that you found difficult, immediately after the lecture, tutorial or lab session finishes. If this cannot be accomplished, then make sure you see your lecturer or tutor as soon as possible to resolve any problems.

7. What you can expect from your lecturer and/or the teaching team

Feedback
Your lecturer and/or the teaching team will provide you with oral and written feedback on class test papers and assignments.

Consultation
See Heading 4 on page 2 for consultation time. Meeting is also available by appointment.

General conduct and behaviour
It is our aim to create a learning environment so that you may reach your full potential in this unit. Accordingly, you can expect from the lecturing staff in this unit to:

• prepare thoroughly for each teaching session;
• be on time for each lecture, tutorial and laboratory session;
• ensure that you understand the unit requirements and material;
• be available to assist students during the consultation times (as indicated above);
• treat you equitably, and with courtesy and respect;
• report immediately, any issues or concerns related to student academic and non-academic misconduct to the relevant authority, according to the UWS Misconduct Policy.

Sometimes the best laid plans do go astray! In the unlikely occurrence of this happening, you will be notified about any changes to the scheduled activities, at least 24-hours in advance (if possible), via an announcement on iUWS.

8. How to use this learning guide

This Learning Guide supplements the Unit Outline and is designed to help you navigate through the unit. It will help you focus on what you need to do to prepare for the various assessment tasks throughout the unit. You should consult the Learning Guide on a regular basis, as you plan your study, as this guide contains information on how best to prepare for each assessment task.

The Learning Guide also offers tips to assist you in developing the skills and techniques of an effective, independent learner. However, if you have any particular problems or issues regarding this Unit, please take these up with the Unit Coordinator so that they may be resolved as soon as possible. As an adult learner, it is expected that you will be responsible for your own learning and take the necessary and appropriate steps to ensure your success.
The University has a number of policies that relate to teaching and learning. Important policies affecting students include:

- Assessment Policy
- Examinations Policy
- Special Consideration Policy
- Review of Grade Policy
- Assessment Practice – Fundamental Code
- Misconduct – Student Academic Misconduct Policy (see extract of the policy below under the heading "What is Academic Misconduct?")
- Misconduct – Student Non-academic Misconduct Policy
- Enrolment Policy (includes a section on the UWS Student Email Account)
- Bullying Prevention Policy and Guidelines
- Sexual Harassment Prevention Policy

There are two policies that relate to misconduct – academic and non-academic misconduct. Breaches of these policies can have very serious consequences. It is essential that you are familiar with these policies and how to avoid misconduct of any type.

**What is Academic Misconduct?**

Academic Misconduct may involve plagiarism, collusion or cheating. Plagiarism involves submitting or presenting work in a unit as if it were the student’s own work when, in fact, it was not. Collusion includes inciting, assisting, facilitating, concealing or being involved in plagiarism, cheating or other academic misconduct with others. Cheating includes dishonest conduct (or attempted dishonest conduct) in exams.

For the full definition of academic misconduct and the consequences of such behaviour, you are advised to read the Misconduct – Student Academic Misconduct Policy in its entirety, refer to: http://policies.uws.edu.au/view.current.php?id=00051

**The School of Computing, Engineering and Mathematics definitions of Minor and Substantial Breaches of the UWS Academic Misconduct policy are below:**

**Plagiarism**

*Minor breach:* A minor breach occurs when the weighting of the assessment task is less than 10%, and less than 20% of the work submitted is taken from another source without reference to the original source or author.

*Substantial breach definition:* A substantial breach occurs when:

1. The weighting of the assessment task is more than 10%, and 20% or more of the work submitted is taken from another source without reference to the original source.
2. If a student has been found to have already committed an act of plagiarism and warned about it, whether it be a minor or substantial breach, then the next allegation will be treated as a substantial breach.

**Cheating**
1. Dishonest or attempted dishonest conduct during an examination, for example speaking to other candidates or otherwise communicating with them, leaving answer papers exposed for other students to view and/or copy or attempting to view another student’s solutions, would be deemed as minor. However, if this behaviour continued after the student had been asked to desist, then the breach would be treated as substantial.

2. Bringing into the examination room any textbook, notebook, memorandum, other written material or mechanical or electronic device (including mobile phones), or any item not authorised by the examiner would be treated as minor. However, if the student does not surrender the unauthorised item, then a substantial breach would have occurred.

3. Writing an examination or part of it, or consulting any person or materials outside the confines of the examination room without permission to do so, would constitute a substantial breach.

4. Cheating in take-home examinations, which includes, but it not limited to: making notes, papers or answers in connection with the examination (in whatever form) to others without the permission of the relevant lecturer; receiving answers, notes or papers in connection with the examination (in whatever form) from another student, or another source without the permission of the relevant lecturer; and the unauthorised collaboration with another person or student in the formulation of an assessable component of work constitutes a substantial breach.

Other Academic Misconduct

1. Tampering or attempts to tamper with examination scripts, class work, grades or class records, will be regraded as substantial.

2. Failure to abide by the directions of an academic member of staff regarding the individuality of work to be handed in, will, in the first instance be treated as minor. However, any reoccurrence of such behaviour will be regarded as substantial.

3. Acquisition, attempted acquisition, possession or distribution of examination materials or information without the authorisation of the academic member of staff will be regarded as substantial.

4. Impersonation of another student in an examination or other class assignment will be regarded as substantial.

5. Falsification or fabrication of practical or laboratory reports will be regarded as substantial.

6. Non-authorised use of tape recording of lectures will be regarded as minor, except where the student/s has been asked to desist and refuses to comply. This continued abuse will be regarded as substantial.

There are many resources to help you avoid academic misconduct. The library staff (see p. 17) can help you with referencing and the Student Learning Unit can assist with academic writing and plagiarism. If you are unsure about any of your work you should also ask your tutor or lecturer for advice and feedback.
What is Non-academic Misconduct?
Non-academic misconduct includes unlawful activities and crimes, falsifying documents (like a medical certificate or academic records), harassing other students (or staff), stealing or damaging university property (like library books or computers) and disrupting other students or staff. These are just some of the types of non-academic misconduct and while these things are rare they do happen. If you believe you have been the victim of non-academic misconduct or you are aware of any academic misconduct it is very important that you report it.

You should report all matters of academic misconduct directly to your Head of Program.

10. What to do if you have a problem/concern

If you have a concern about this unit please contact the unit coordinator in the first instance. If you would prefer to speak to someone else you are advised to contact your Head of Program (see the online handbook to identify your Head of Program and their contact details http://handbook.uws.edu.au/hbook/).

More information about resolving complaints is available on the UWS website. http://uws.clients.squiz.net/opq/planning_and_quality/complaints_management_and_resolution

The University also has a confidential Complaints Handling department (see link above for contact details). You may contact this department of the University at any time however we would appreciate the opportunity to resolve this directly first.
Teaching and Learning Activities

Details of the teaching resources and learning activities are provided in this section of the learning guide.

11. Schedule of Learning and Teaching Activities


Lectures: Tuesday, 09:00 - 11:00, Parramatta South E.A.1.03
Practical/Tutorials: Tuesday, 16:00 - 18:00, Parramatta South E.A.L.G.17
Consultation: Tuesday, 11:00 – 13:00, Weeks 1 – 8, 10 – 14, or by appointment

Essential Equipment and/or Resources: A scientific calculator and the R software package.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Student Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Introduction to time series, fundamental concepts</td>
<td>Lecture, No Practical/Tutorial.</td>
</tr>
<tr>
<td>2</td>
<td>Trends</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
<tr>
<td>5</td>
<td>Model Specification</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
</tbody>
</table>
### 200038 Time Series and Forecasting

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Student Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Parameter Estimation</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
<tr>
<td>7</td>
<td>Model Diagnostics</td>
<td>Lecture, <strong>Mid-session Exam</strong>, 16:00-17:00, Tuesday, 11/09/2012</td>
</tr>
<tr>
<td>8</td>
<td>Forecasting</td>
<td>Lecture, <strong>Assignment 1</strong> due on Tuesday, 18/09/2012</td>
</tr>
<tr>
<td>9</td>
<td>Intra-session Break</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Seasonal Models</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
<tr>
<td>11</td>
<td>Time Series Regression Models</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
<tr>
<td>13</td>
<td>Application and Extension of the GARCH Model</td>
<td>Lecture, Practical/Tutorial, <strong>Assignment 2</strong> due on Tuesday, 23/10/2012.</td>
</tr>
<tr>
<td>14</td>
<td>Revision.</td>
<td>Lecture, Practical/Tutorial.</td>
</tr>
<tr>
<td>15</td>
<td>STUVAC</td>
<td></td>
</tr>
</tbody>
</table>

Assessment Details

This section provides detailed information about the assessment activities in this unit. You are encouraged to use this as a guide when you are working on each assessment task.

12. Learning outcomes and assessment

On successful completion of this subject, it is expected that the student should be able to:

1. apply in the context of time series analysis the fundamental concepts of probability and statistics;
2. identify different time series models, estimate parameters, and apply diagnostic checking in time series models;
3. implement the theory of econometric methods;
4. compare and contrast time series models and forecasting techniques.

There are 4 main assessment activities in this unit.

<table>
<thead>
<tr>
<th>Type of Assessment</th>
<th>Weighting</th>
<th>Due Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid-semester test</td>
<td>10%</td>
<td>Week 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16:00-17:00, Tuesday, 11/09/2012</td>
</tr>
<tr>
<td>Assignment 1</td>
<td>15%</td>
<td>Week 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuesday, 18/09/2012</td>
</tr>
<tr>
<td>Assignment 2</td>
<td>25%</td>
<td>Week 13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tuesday, 23/10/2012</td>
</tr>
<tr>
<td>Final Examination</td>
<td>50%</td>
<td>The Final Exam period</td>
</tr>
<tr>
<td>Total Marks (100)</td>
<td>100%</td>
<td></td>
</tr>
</tbody>
</table>
Note: In order to pass this unit you must also obtain a minimum combined overall mark of 50/100. No student, regardless of performance throughout the session, should expect to attain a passing grade in this unit without attaining:

(i) at least 40% in the final examination; and

(ii) at least 40% for the continuous assessment (tests and assignments).

13. Assessment details

<table>
<thead>
<tr>
<th>Section C: Assessment Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Assessment</td>
</tr>
<tr>
<td>----------------------</td>
</tr>
<tr>
<td>Mid-semester test</td>
</tr>
<tr>
<td>Assignment 1</td>
</tr>
<tr>
<td>Assignment 2</td>
</tr>
<tr>
<td>Final Examination</td>
</tr>
<tr>
<td>Total Marks (100)</td>
</tr>
</tbody>
</table>

Students can expect the assessment items to be returned within two weeks of the submission date. Final marks and grades are subject to confirmation by the School and College Assessment Committee which may scale, modify or otherwise amend the marks and grades for the unit, as may be required by University policies.

Assessment Requirements

An overall mark of at least 50% is required to pass the unit. Final marks and grades are subject to confirmation by the School and College Assessment Committee which may scale, modify or otherwise amend the marks and grades for the unit, as may be required by University policies.

In order to pass this unit you must obtain a minimum combined overall mark of 50/100. No student, regardless of performance throughout the session, should expect to attain a passing grade in this unit without attaining:

(i) at least 40% in the final examination; and

(ii) at least 40% for the continuous assessment (test and assignments).

Formal Examinations

- The mid-semester test will be held in Week 7 and be based on the material covered in weeks 1 to 5 (inclusive). It will be a written exam of 1 hour duration. The test will be held on Tuesday, 11/09/2012 from 16:00 to 17:00 in Parramatta South EA.LG.17. The only written material you may bring into the test is 2 single A4 sheets (4 pages) of summary notes.

- The final examination will be based on all of the material covered in the unit. It will be a 2 hour
partially closed book. You may bring into the test 4 A4 sheets (8 pages) of summary notes. Students must complete the final examination to the satisfaction of the School to obtain a passing grade in this unit. Students who do not attend the final examination should expect to FAIL the unit.

<table>
<thead>
<tr>
<th>Assignment Cover Sheet</th>
<th>Hard copy assignments must be accompanied by a signed Assignment Cover Sheet (see Appendix D and <a href="http://www.uws.edu.au/currentstudents/current_students/managing_your_study/forms">http://www.uws.edu.au/currentstudents/current_students/managing_your_study/forms</a>) and submitted as outlined below.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Submission of Assessment Tasks</td>
<td>Assignments must be submitted in the prescribed format to the lecturer by the close of business of the due date (see above). Students are required to keep a copy of all written work submitted.</td>
</tr>
<tr>
<td>Resubmission</td>
<td>Resubmission of an assignment is NOT permitted</td>
</tr>
<tr>
<td>Late Submission</td>
<td>A student who submits a late assessment without approval for an extension will be penalised by 10% per day up to 10 days, i.e. marks equal to 10% of the assignment’s weight will be deducted as a ‘flat rate’ from the mark awarded. For example, for an assignment that has a possible highest mark of 50, the student’s awarded mark will have 5 marks deducted for each late day. Saturday and Sunday each count as one day. Assessments will not be accepted after the marked assessment task has been returned to students who submitted the task on time.</td>
</tr>
<tr>
<td>Extension of Due Date for Submission of Assessment Tasks</td>
<td>If a student needs to apply for a short extension of time to complete an assessment item, they should complete the <a href="http://library.uws.edu.au/citing.php">Application for Extension of Time for Assignment</a> form available on the Unit’s website (vUWS) or from the School Office. This form needs to be submitted before the due date of the assignment. Students should complete Sections A and C, then submit the form to their Unit Coordinator/Advisor, who will complete Section B. If the extension is approved, the student should leave Sections A and B with the Unit Coordinator/Advisor, and attach Section C to their assignment when they submit it. An application for an extension does not automatically mean that an extension will be approved. Where special consideration is sought for circumstances involving more than three consecutive days or more than five days within a teaching period, students should complete a <a href="http://library.uws.edu.au/citing.php">Special Consideration Application</a>, available from the UWS website or a Student Centre.</td>
</tr>
<tr>
<td>Return of Assessment Material</td>
<td>The lecturer will return assignments in class as soon as they are marked. If there are no classes (in the case of an end of session assignment), the lecturer will give the class a time and venue when the assignments can be collected. There will be a common collection date for distribution of assignments at the end of the session. Alternatively, an appropriately sized, self-addressed, stamped envelope can be attached to your assignment upon handing it in, and your marked assignment will be returned to you via post. Once the projects are marked there will be an announcement in the web ct site instructing on how to collect them. Any unclaimed work will be held for a period of one month after the end of the session and then destroyed.</td>
</tr>
</tbody>
</table>

**Assignment Cover Sheet** (next page)
### Assignment Cover Sheet

**School of Computing, Engineering and Mathematics**

<table>
<thead>
<tr>
<th><strong>Student Name</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Student Number</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Unit Name and Number</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Lecturer/Tutor</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Title of Assignment</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Length</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Due Date</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Date Submitted</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Campus Enrolment</strong></td>
<td></td>
</tr>
</tbody>
</table>

#### DECLARATION

I hold a copy of this assignment that I can produce if the original is lost or damaged.

I hereby certify that no part of this assignment/product has been copied from any other student’s work or from any other source except where due acknowledgement is made in the assignment. No part of this assignment/product has been written/produced for me by another person except where such collaboration has been authorized by the subject lecturer/tutor concerned.

I hereby certify that I have read and understand what the School of Computing, Engineering and Mathematics defines as minor and substantial breaches of misconduct as outlined in the learning guide for this unit.

**Signature:** .........................................................................................................................

**Note:** An examiner or lecturer/tutor has the right not to mark this assignment if the above declaration has not been signed.
14. Sample questions and marking schemes

Question 1. (10 Marks) Let \( \{e_t\}, \ t = 0, \pm 1, \pm 2, \ldots \), be a sequence of independent and identically distributed (iid) random variables with mean zero and variance \( \sigma^2 \). Let \( Y_t = e_t + ae_{t-1} \), where \( a \) is some constant. Show that \( Y_t \) is weakly stationary.

Solution

For all \( t \) the mean function of \( Y_t \) is given by

\[
E(Y_t) = E(e_t + ae_{t-1}) \\
= E(e_t) + E(ae_{t-1}) \\
= E(e_t) + aE(e_{t-1}) \quad (1 \text{ Mark}) \\
= 0 + a \times 0 \\
= 0.
\]

This shows that the mean function is constant over time. (1 Mark)

For arbitrary \( t \) and \( k \), the autocovariance function of \( Y_t \) is given by

\[
\text{Cov}(Y_t, Y_{t+k}) = \text{Cov}(e_t + ae_{t-1}, e_{t-k} + ae_{t-k-1}) \\
= \text{Cov}(e_t, e_{t-k}) + \text{Cov}(e_t, ae_{t-k}) + \text{Cov}(ae_{t-1}, e_{t-k}) + \text{Cov}(ae_{t-1}, ae_{t-k}) \quad (1 \text{ Mark}) \\
= \text{Cov}(e_t, e_{t-k}) + a\text{Cov}(e_t, e_{t-k}) + a\text{Cov}(e_{t-1}, e_{t-k}) + a^2\text{Cov}(e_{t-1}, e_{t-k}).
\]

Since the \( e_t \)'s are iid, we have, for \( t = 0, \pm 1, \pm 2, \ldots \),

\[
\text{Cov}(e_t, e_{t-k}) = \begin{cases} \sigma^2, & k = 0, \\ 0, & k \neq 0. \end{cases} \quad (1 \text{ Mark})
\]

Consequently, if \( k = 0 \), then for \( t = 0, \pm 1, \pm 2, \ldots \),

\[
\text{Cov}(Y_t, Y_{t+k}) \bigg|_{k=0} = \text{Cov}(e_t, e_t) + a\text{Cov}(e_t, e_{t-1}) + a\text{Cov}(e_{t-1}, e_t) + a^2\text{Cov}(e_{t-1}, e_{t-1}) \\
= \text{Var}(e_t) + a \times 0 + a \times 0 + a^2\text{Var}(e_{t-1}) \quad (1 \text{ Mark}) \\
= \sigma^2 + a^2\sigma^2 \\
= (1 + a^2)\sigma^2.
\]

If \( k = 1 \), then for \( t = 0, \pm 1, \pm 2, \ldots \),
\[ \text{Cov}(Y_t, Y_{t-k}) \mid_{k=0} = \text{Cov}(e_t, e_{t-k}) + a \text{Cov}(e_t, e_{t-2}) + a^2 \text{Cov}(e_{t-1}, e_{t-2}) \]
\[ = 0 + a \times 0 + a \sigma^2 + a^2 \times 0 \]
\[ = a \sigma^2, \quad (1 \text{ Mark}) \]

Similarly, for \( k = -1 \) and for \( t = 0, \pm 1, \pm 2, \ldots \), \( \text{Cov}(Y_t, Y_{t-k}) \mid_{k=-1} = a \sigma^2. \quad (1 \text{ Mark}) \)

Therefore, for all \( t = 0, \pm 1, \pm 2, \ldots \),
\[ \text{Cov}(Y_t, Y_{t-k}) = \begin{cases} 
(1 + a^2) \sigma^2, & k = 0, \\
ka \sigma^2, & |k| = 1, \\
0, & |k| > 1. 
\end{cases} \quad (1 \text{ Mark}) \]

This implies that \( \text{Cov}(Y_t, Y_{t-k}) = \text{Cov}(Y_0, Y_k) \) for all \( t, k = 0, \pm 1, \pm 2, \ldots \). \( (1 \text{ Mark}) \)

Because the mean function is constant over time and the autocovariance function \( \text{Cov}(Y_t, Y_{t-k}) = \text{Cov}(Y_0, Y_k) \) for all \( t \) and \( k \), \( Y_t \) is weakly stationary. \( (1 \text{ Mark}) \)

**Question 2. (5 Marks)** Let \( \{Y_t\} \) be a stationary process. Show that if \( \rho_1 < 1/2 \), then the variance of \( \nabla Y_t \) is larger than that of \( Y_t \).

**Solution** The variance of \( \nabla Y_t \) is given by
\[ \text{Var}(\nabla Y_t) = \text{Var}(Y_t - Y_{t-1}) \]
\[ = \text{Var}(Y_t) + \text{Var}(Y_{t-1}) - 2 \text{Cov}(Y_t, Y_{t-1}) \]
\[ = \text{Var}(Y_t) + \text{Var}(Y_{t-1}) - 2 \rho_1 \text{Var}(Y_t) \]
\[ = 2(1 - \rho_1) \text{Var}(Y_t). \quad (1 \text{ Mark}) \]

Hence, If \( \rho_1 < 1/2 \), then \( 2(1 - \rho_1) > 1 \) and \( \text{Var}(\nabla Y_t) > \text{Var}(Y_t). \quad (1 \text{ Mark}) \)

**Question 3. (10 Marks)** Let \( \{Y_t\}, t = 0, \pm 1, \ldots \), be the ARMA(1,1) process \( Y_t = \phi Y_{t-1} + e_t - \theta e_{t-1}, \) where \( e_t \sim \text{WhiteNoise}(0, \sigma^2), \phi \neq -\theta, |\phi| < 1 \) and \( |\theta| < 1. \) Show that \( \gamma_0 = \sigma^2(1 - 2\phi \theta + \theta^2)/(1 - \phi^2) \) and
\[ \gamma_0 = \phi \gamma_{-1} + \sigma^2 - \theta(\phi - \theta)\sigma^2 = \phi \gamma_{-1} + [1 - \theta(\phi - \theta)]\sigma^2, \\
\gamma_1 = \phi \gamma_0 - \theta \sigma^2, \\
\gamma_k = \phi \gamma_{k-1} \quad \text{for} \ k \geq 2. \]

**Solution** By the property of the ARMA process we have \( E[Y_t] = 0 \) for all \( t \). This implies that
\[ \gamma_k = \text{Cov}(Y_t, Y_{t-k}) \]
\[ = E(Y_t Y_{t-k}) \]
\[ = E[(\phi Y_{t-1} + e_t) - \theta e_{t-1}] Y_{t-k}] \]
\[ = \phi E(Y_{t-1} Y_{t-k}) + E(e_t Y_{t-k}) - \theta E(e_{t-1} Y_{t-k}) \]  
\[ = \phi \gamma_{k-1} + E(e_t Y_{t-k}) - \theta E(e_{t-1} Y_{t-k}). \]

Now
\[ E(e_t Y_t) = E[e_t(\phi Y_{t-1} + e_t - \theta e_{t-1})] \]
\[ = \phi E(e_t Y_{t-1}) + E(e_t^2) - \theta E(e_t e_{t-1}) \]
\[ = 0 + \sigma^2 - 0 \]
\[ = \sigma^2, \]

and
\[ E(e_{t-1} Y_t) = E[e_{t-1}(\phi Y_{t-1} + e_t - \theta e_{t-1})] \]
\[ = \phi E(e_{t-1} Y_{t-1}) - E(\theta e_{t-1}^2) \]
\[ = \phi \sigma^2 - \theta \sigma^2 \]
\[ = (\phi - \theta) \sigma^2. \]

Hence, we have
\[ \gamma_0 = \phi \gamma_{-1} + \sigma^2 - \theta (\phi - \theta) \sigma^2 = \phi \gamma_1 + [1 - \theta (\phi - \theta)] \sigma^2, \]
\[ \gamma_1 = \phi \gamma_0 - \theta \sigma^2, \]
\[ \gamma_k = \phi \gamma_{k-1} \quad \text{for} \quad k \geq 2. \]

Solving the first two equations gives
\[ \gamma_0 = \frac{1 - 2 \phi \theta + \theta^2}{1 - \phi^2} \sigma^2 \]  

and the other \( \gamma_k \)'s can be found by using the iteration above.
Learning Resources and Information

As independent learners you must make choices about the resources you use to help you with your learning activities and assessments in this unit. In the following section we briefly summarize the resources that are available to you.

15. Overview of learning resources

The following table is a quick look-up guide that summarizes the learning resources available in this unit.

<table>
<thead>
<tr>
<th>Resources</th>
<th>Subject Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Coordinator/teaching team</td>
<td></td>
</tr>
<tr>
<td>Library</td>
<td>See the library home page to get help from a Librarian</td>
</tr>
<tr>
<td></td>
<td><a href="http://library.uws.edu.au/">http://library.uws.edu.au/</a></td>
</tr>
<tr>
<td>e-learning tools</td>
<td></td>
</tr>
<tr>
<td>Participation in class</td>
<td></td>
</tr>
<tr>
<td>Reading Lists</td>
<td>Reading lists for each of the discussion topics will be available on rUWS. See also Heading 17 below.</td>
</tr>
</tbody>
</table>

16. People who can help

**Teaching Team**

Dr. Zhi Guo

Email: z.guo@uws.edu.au, Location: Building ER. Room G.14, Parramatta Campus,

Phone: (02) 9685 9283.
200038 TIME SERIES AND FORECASTING

17. Useful reading

Recommended reading lists

Main reference for this unit


Additional references:

18. Online Resources

vUWS
vUWS provides a range of essential online resources in this unit. You are encouraged to check the site regularly for updates. In particular, you will find websites that will help you with any numeracy difficulties you may be experiencing.

Wikipedia
Wikipedia can be a great help with initial information on some topics. However in this unit Wikipedia articles should not be used in assessment tasks.

19. UWS website – Current Students
The “Current Students” page of the UWS web site http://www.uws.edu.au/students contains many important links, including:

- Student Administration – This site contains much of the information necessary for the administration of your course throughout your study at UWS. http://www.uws.edu.au/currentstudents/current_students
- Student Support Services – This site is a useful resource for students and a hub for coordinating developments to improve your university experience. http://www.uws.edu.au/currentstudents/current_students/getting_help/
- e-learning – This is your entry to all aspect of e-learning at UWS, including this unit’s vUWS site. http://www.uws.edu.au/students/onlinesupport
- Students with a disability should visit: http://www.uws.edu.au/currentstudents/current_students/getting_help/disability_services
- Course and unit rules – This site provides information on pre-requisites, co-requisites and other matters concerning how your course is structured http://www.uws.edu.au/currentstudents/current_students/managing_your_study/enrolment/course_and_unit_rules
- Policies – This site includes the full details of policies that apply to you as a UWS student. http://www.uws.edu.au/policies/a-z

20. Referencing Requirements
Normally, in this unit, the assessment tasks will not require referencing. However, if an assessment task does require referencing, then the Harvard, IEEE or APA styles are preferred, for computing/mathematics units, if using LaTeX, ‘plain’ is preferred. Examples of these referencing styles are available on the library website http://library.uws.edu.au/citing.php.