1. (30) A data set of 324 measurements of an industrial robot?s positions are in the robot object in the TSA package. Type library(TSA); data(robot); print(robot) in R to see the data set.

(a) Fit an AR(1) model for these data. Give the equation of the estimated model.
(b) Give a basic plot of the standardized residuals over time and a Q-Q plot of the residuals. Comment on what these tell you about the adequacy of the model.
(c) Give a plot of the sample autocorrelation function of the residuals. Also perform a Ljung-Box test (with K = 30). Comment on what these tell you about whether the errors are independent in this model.
(d) Fit an IMA(1,1) model for these data. Give the equation of the estimated model.
(e) Compare the results from parts (a) and (d) using AIC.

2. (30) I have put the following dataset on blackboard: Gasprices: average price (US dollars per gallon) for regular gasoline in the United States; there are n = 145 weekly observations collected from 1/5/2009 to 10/10/2011 (Source: Rajon Coles, Fall 2011). Using the methods from Chapter 5, identify a small set of candidate ARIMA(p, d, q) models for the dataset. You may need to transform the data before considering differencing. There may be a single model that emerges as a "clear favorite" or there may not. Write up detailed notes that describe how you decided on the model(s) you did. Your summary should convince me that your model(s) is (are) worthy of further consideration.

(a) After a potential transformation, fit a set of candidate models (3 or fewer models) to the dataset. Discuss your findings.
(b) Perform diagnostic check for each model: check residuals for normality (histogram, qq-plot), the ACF, and the Ljung-Box test.
(c) Choose a final model (if all fit fine, choose the one with the smallest AIC). Report your final model and calculate forecasts and prediction intervals for 5 future values. Display the forecasts and prediction bands visually like.

3. (40) A data set of public transportation boardings in Denver from August 2000 through December 2005 are in the boardings object in the TSA package. These data are already logged. To see the data, you can type in R:
library(TSA); data(boardings); log.boardings = boardings[,1]; print(log.boardings)

(a) Give a time series plot of these data. Comment on the plot and any seasonality. Is it reasonable to use a stationary model for this time series?
(b) Plot the sample ACF of the series. Interpret what the plot tells you.
(c) Choose a seasonal ARIMA model that fits the data. Write down your model and the corresponding AIC.
(d) Check residuals for normality (histogram, qq-plot), for independence (ACF and the Ljung-Box test). Comment on your findings.