1. Briefly explain the following concepts (7 points each):
   a) Stationarity
   b) Partial autocorrelation of order k
   c) Median lag

2. A market researcher is interested in the total amount of money per year spent by college students on clothing. From 25 years of annual data, the following estimated regression was obtained through ordinary least squares

\[ Y_t = 50.72 + 0.124 \log(X_{1t}) + 0.271 X_{2t} + 0.75 \log(Y_t) + \epsilon_t \]

\[ (0.047) \quad (0.213) \quad (0.05) \]

Durbin-Watson statistic \( d = 1.821 \)

where figures in brackets below coefficient estimates are the corresponding estimated standard errors, and

\( Y_t = \) Expenditure on clothes, in real dollars

\( X_{1t} = \) Disposable income of students, in real dollars

\( X_{2t} = \) Index of advertising, aimed at the student market, on clothes

(a) Test at the 1% level the null hypothesis that, all else equal, advertising does not affect expenditures on clothes in this market. (10 points)

(b) Interpret the estimated parameter on \( \log(X_{1t}) \). (5 points)
(c) What would be the expected impact over time of increase in advertising? (9 points)

(d) Test the null hypothesis that the error terms are not autocorrelated against the alternative that they follow a first-order autoregressive model with negative parameter. (12 points)

(e) Suppose that your test shows serial correlation of errors, what would be the consequences if you still use the OLS to estimate the model. (9)

3. Write down the expressions for time-series $X_t$, when it is generated by ARIMA (1, 2, 3); by ARIMA (1,0,1); and by ARIMA (0, 1, 0). (12 points)

4. Suppose that you selected ARIMA (1,1,1) model for a series $X_t$ for $t=1, 2, ..., 50$, how would you use it to forecast $X_{51}$ (write down the model and show details)? (12 points)
5. Suppose that you have 160 quarterly observations on U.S. GDP, outline the detailed procedure of fitting an appropriate non-seasonal ARIMA model to the data and obtain forecasts for next four quarters. (16 points)