Sl. No	Questions
1	1. Quarterly demand for certain parts manufactured by Jack and Jill company is shown in Table 1.

TABLE 1 Quarterly demand

Year	Quarter	Value
2012	Q1	75
	Q2	60
	Q3	54
	Q4	59
2013	Q1	86
	Q2	65
	Q3	63
	Q4	80
2014	Q1	90
	Q2	72
	Q3	66
	Q4	85
2015	Q1	100
	Q2	78
	Q3	72
	Q4	93

(a) Calculate the seasonality index for different quarters using the first 3 years of data.

(b) Develop forecasting models using moving average, single exponential smoothing, and an appropriate
ARMA model after de-seasonalizing the data (assume multiplicative model, $Y_t = T_t \times S_t$).

(c) Forecast the demand for 2015 (all four quarters) using moving average, exponential smoothing, and ARMA. Calculate RMSE, MAPE, and Theil's coefficient.

2	Data on monthly demand for a product over 3 years (between 2013 and 2015) is given in Table 2. TABLE 2 Monthly demand

Month	2013	2014	2015
January	15	23	25
February	16	22	25
March	18	28	35
April	18	27	36
May	23	31	36
June	23	28	30
July	20	22	30
August	28	28	34
September	29	32	38
October	33	37	47
November	33	34	41
December	38	44	53

(a) Calculate the seasonality index using methods of averages.

(b) De-seasonalize the data assuming that Yt is product of trend and seasonality.

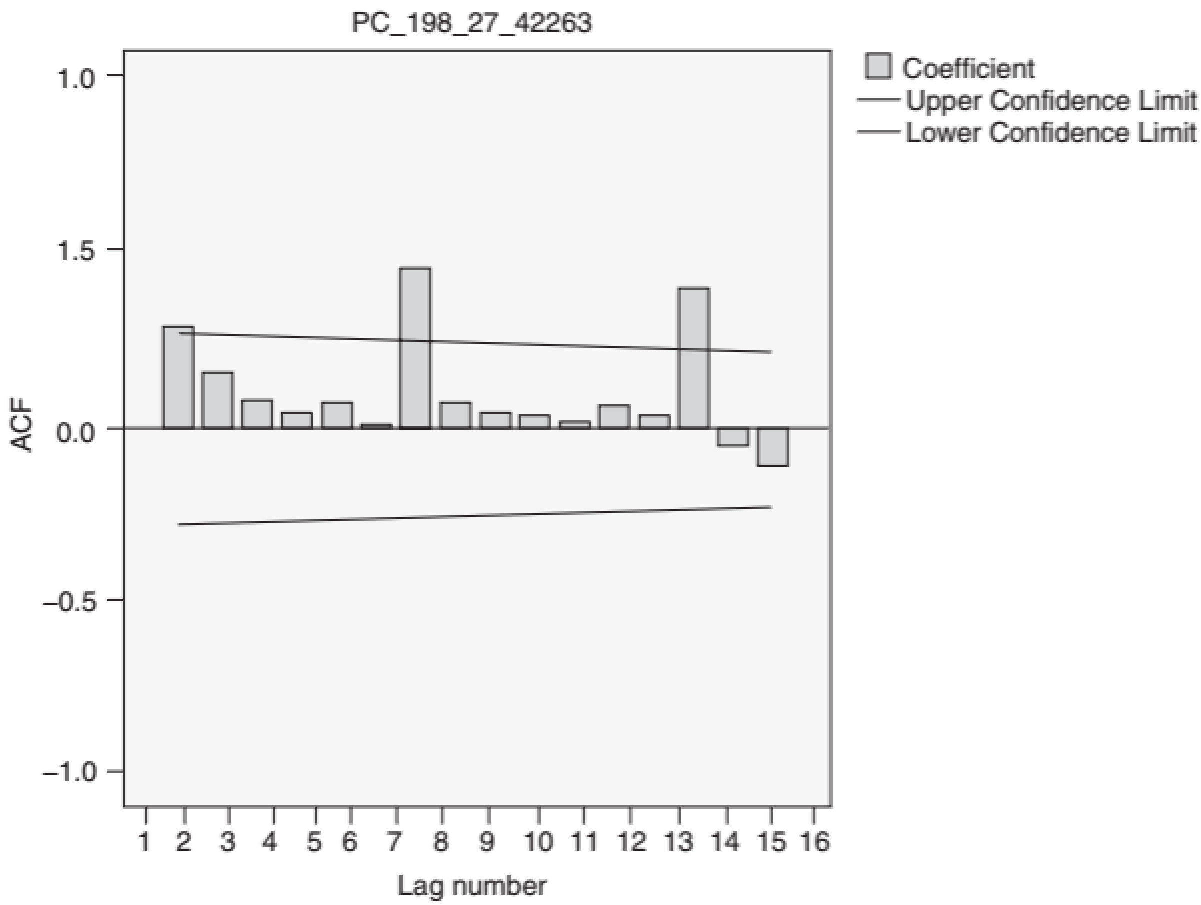
(c) Develop the best forecasting model by comparing MAPE of MA, ES, and ARMA models. Compare the models using MAPE and Theil's coefficient.

3	Television rating points of a television program over 30 episodes is shown in Table 3. TABLE 3. Television rating points

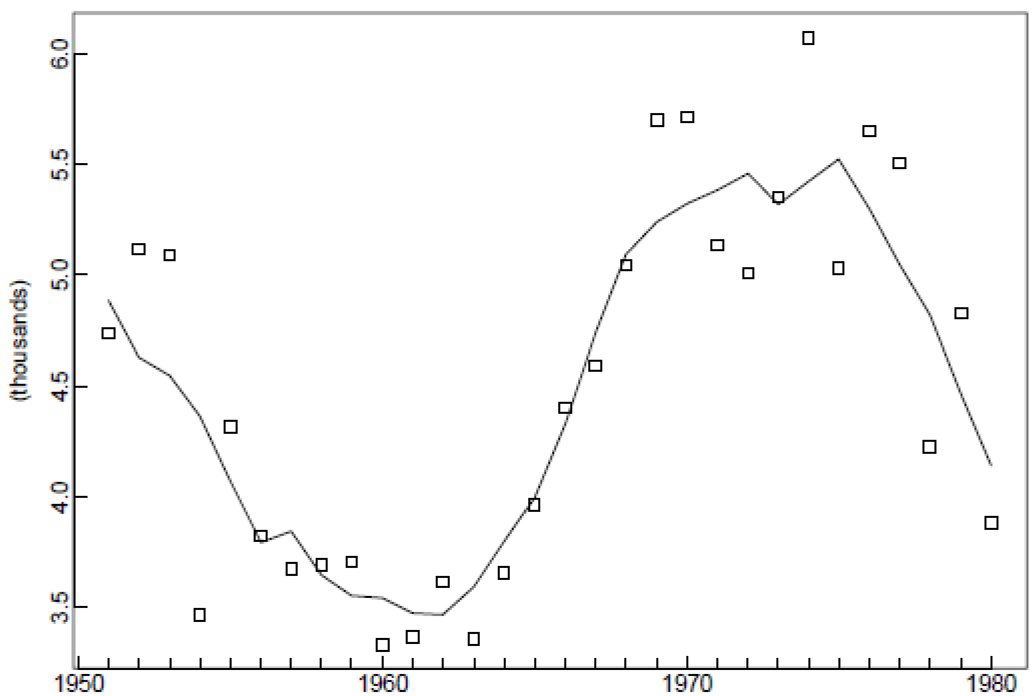
Episode	1	2	3	4	5	6	7	8	9	10
TRP	7.98	9.8	9.53	7.23	7.34	9.62	9.8	7.9	8.26	8.17
Episode	11	12	13	14	15	16	17	18	19	20
TRP	8.36	8.5	9.03	9.82	9.77	10.77	9.46	9.31	10.32	9.03
Episode	21	22	23	24	25	26	27	28	29	30
TRP	10.22	10.28	11.99	11.21	9.81	9.35	9.93	11.22	10.4	10.94

(a) Develop a forecasting model using regression Yt = b0 + b1 t, where Yt is the TRP at time t. Is there any trend in the data? Use the regression model developed to answer.
(b) Is there an auto-correlation in the data? Conduct an appropriate hypothesis test to justify your answer.
(c) The television channel would like to replace the program with a new program, the average TRP of new program will be 8 points. Based on the model developed, comment whether they should replace the program with a new program.
(d) Calculate the probability that the TRP for episode 31 will be more than 10.

4 Auto-correlation function and partial auto-correlation functions for a data set are shown in Figures 4. and 5, respectively.



5	Briefly explain the ARMA process and write an equation for ARMA (1,1)
6	How do we determine whether an input time series is stationary or not?
7	What is the purpose of differencing in an ARIMA model? How are the parameters selected?
8	What is the use of 'X' in ARIMAX?
9	Let $\{Z_t\}$ be a sequence of independent normal random variables, each with mean 0 and variance σ^2, and let *a*, *b*, and *c* be constants. Which, if any, of the following processes are stationary? For each stationary process specify the mean and auto covariance function. a. $X_t = a + bZ_t + cZ_{t-2}$ b. $X_t = Z_1 \cos(ct) + Z_2 \sin(ct)$ c. $X_t = Z_t \cos(ct) + Z_{t-1} \sin(ct)$ d. $X_t = a + bZ_0$ e. $X_t = Z_0 \cos(ct)$ f. $X_t = Z_t Z_{t-1}$
10	Let $\{X_t\}$ be the moving-average process of order 2 given by

	$X_t = Z_t + \vartheta Z_{t-2}$, where $\{Z_t\}$ is WN $(0, 1)$. a. Find the auto covariance and autocorrelation functions for this process when $\vartheta = .8$. b. Compute the variance of the sample mean $(X_1 + X_2 + X_3 + X_4)/4$ when $\vartheta = .8$. c. Repeat (b) when ϑ _ $-.8$ and compare your answer with the result obtained in (b).
11	Let $\{X_t\}$ be the AR(1) process defined in Example 1.4.5. a. Compute the variance of the sample mean $(X_1 + X_2 + X_3 + X_4)/4$ when $\varphi = .9$ and $\sigma^2 = 1$. b. Repeat (a) when φ _ $-.9$ and compare your answer with the result obtained in (a).
12	What is an AR (1) process? Is there any assumptions that an AR process has to satisfy?
13	What are ACF and PACF?
14	How do we select the parameters of a MA (1) process?
13	(Using ITSM to plot the deaths data.) In ITSM select File>Project>Open> Univariate, click OK, and open the project DEATHS.TSM. The graph of the data will then appear on your screen. To see a histogram of the data, click on the sixth yellow button at the top of the ITSM window. To see the sample autocorrelation function, click on the second yellow button. The presence of a strong seasonal component with period 12 is evident in the graph of the data and in the sample autocorrelation function.
14	(Using ITSM to smooth the strikes data.) Double-click on the ITSM icon, select File>Project>Open>Univariate, click OK, and open the file STRIKES. TSM. The graph of the data will then appear on your screen. To smooth the data, select Smooth>Moving Ave, Smooth>Exponential, or Smooth>FFT. Try using each of these to reproduce the results shown in Figures 1.18, 1.21, and 1.22.  Figure 1-18 Simple 5-term moving average $\hat{m}_t$ of the strike data from Figure 1.6.

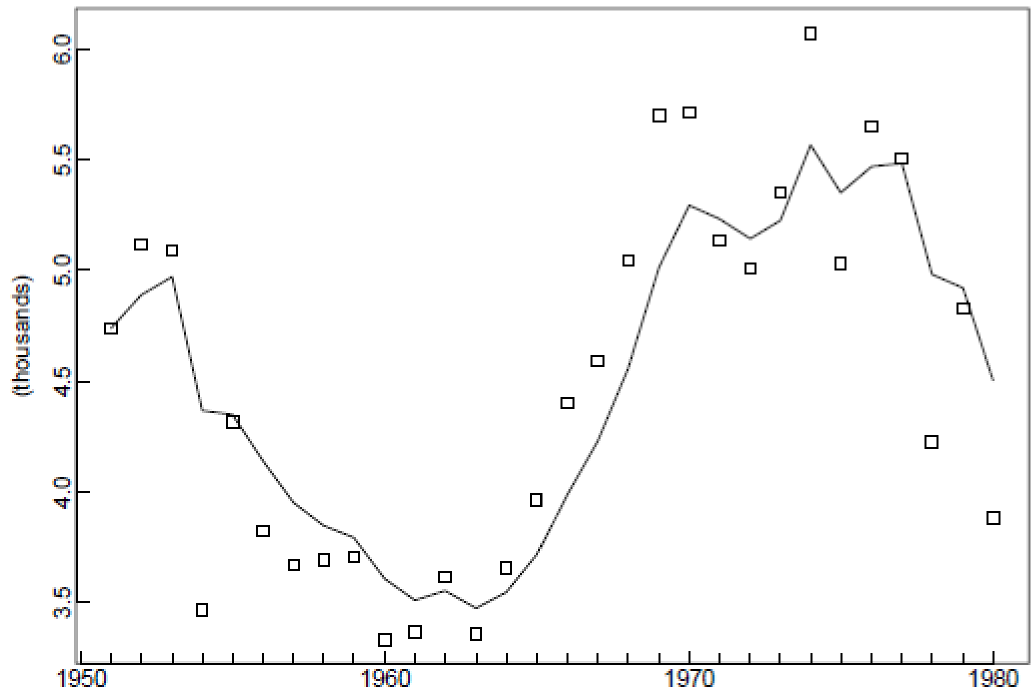


Figure 1-21 Exponentially smoothed strike data with α _ 0.4.

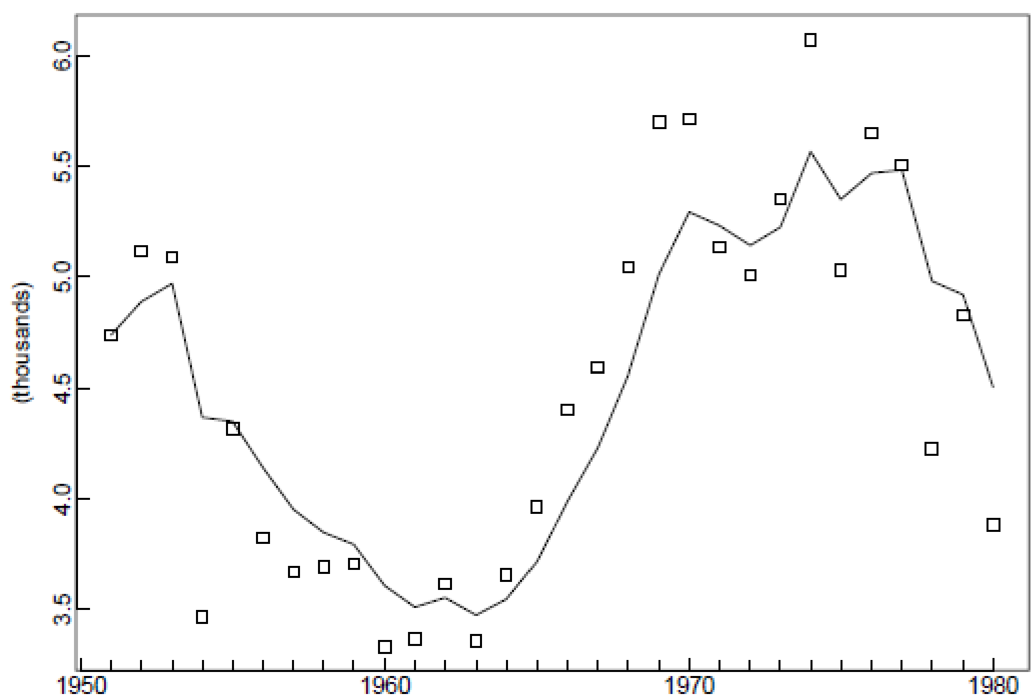


Figure 1-22 Strike data smoothed by elimination of high frequencies with f _ 0.4.