SECTION A: 20 marks

Refer to the figure "Decomposition of additive time series". The figure represents the decomposition of observed (monthly) inflation series.

Decomposition of additive time series
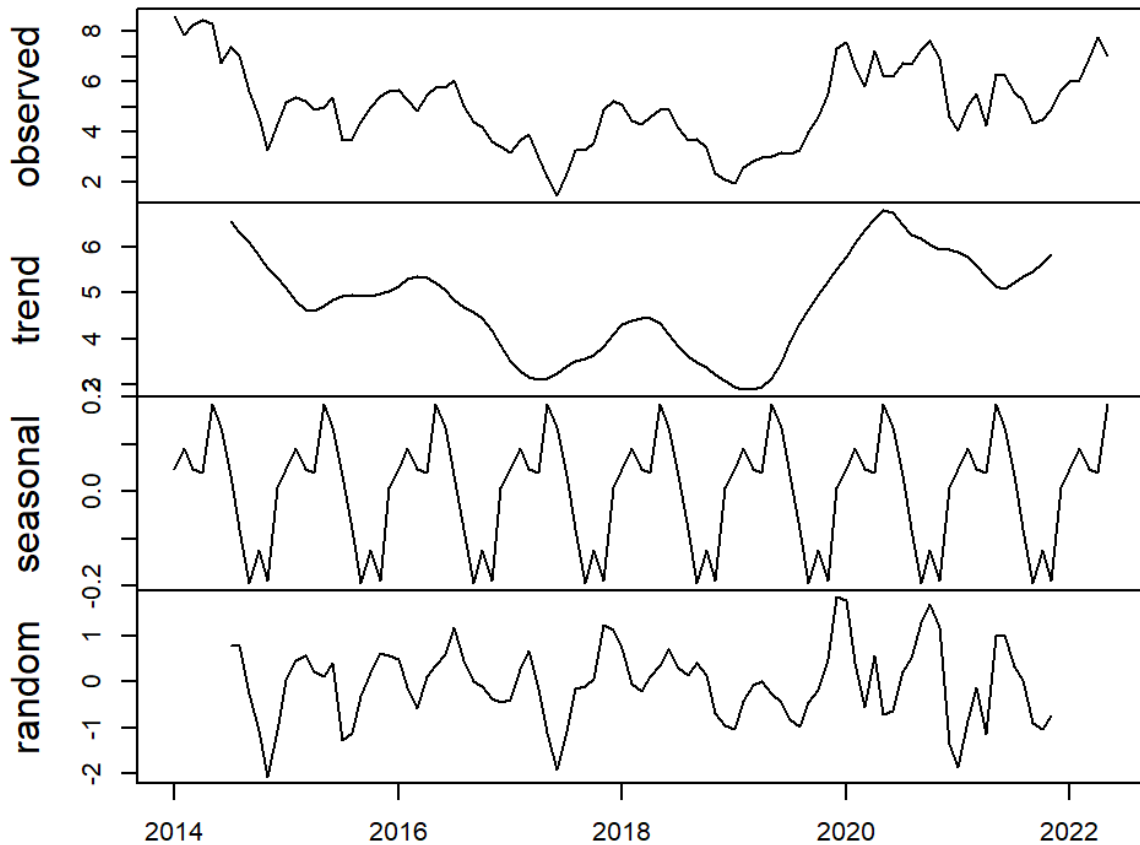
A1a (CO1) Explain meaning of the time series components shown above. (5 marks)

OR

A1b (CO1) How can you find the de-seasonalised (inflation) series? Explain. (5 marks)

A2a (CO2) Explain the importance of visualisation with specific reference to time series data. (5 marks)

OR

A2b What are the uses of autocorrelation function (ACF) and partial auto-correlation function (PACF) plots in time series analysis? (CO2)

(5 marks)

A3a (CO3) Consider the following AR equation

$$y_t = a_1 y_{t-1} + a_2 y_{t-2} + \varepsilon_t$$

Prove that first order autocorrelation

$$\rho_1 = \frac{a_1}{1 - a_2}$$

state your assumptions. (5 marks)

OR

A3b (CO3) State unit root equation(s) corresponding to the ADF test. State the null and alternative hypothesis corresponding to the stated equation(s). (5 marks)

A4a (CO4) Forecasting horizon should be shorter. Why or why not? Provide valid reason. (5 marks)
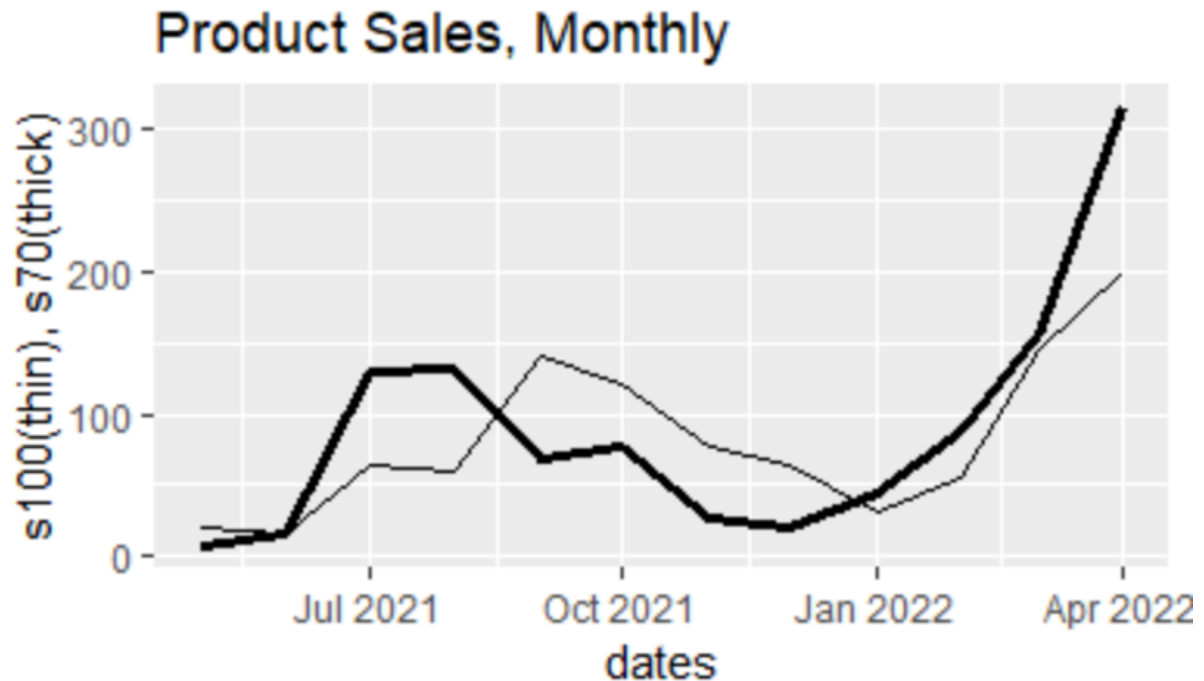
OR

A4b (CO4) Discuss a few ways of evaluating the forecast accuracy of any time series model or technique? (5 marks)

SECTION B – CASE STUDY (20 Marks)

A plot of sales of two differentiated products of a company is given below. The products are s100 (thin line) and s70 (thick line).

Product Sales, Monthly

An analyst finds that both series are stationary. S/he estimated the following ARIMA models.

	s70 model 1	s70 model 2	S70 model 3	s100 model 1	s100 model 2	s100 model 3
sale$_{t-1}$	-0.17	0.61**	-	0.67**	0.63**	-
sale$_{t-2}$	-	-	-	-	-	-
sale$_{t-3}$	-	-	-	-	-	-
ε_{t-1}	1.65***	0.62**	0.77***	-	0.17	0.81***
ε_{t-2}	1.00**	-	-	-	1.00	-
ε_{t-3}	-	-	-	-	-	-
Mean or constant	111.76**	121.07	99.30***	89.55	105.84**	86.77***
Observations	12	12	12	12	12	12
Log Lokelihood	-66.31	-66.9	-67.81	-62.92	-61.95	-62.26
AIC	142.6	141.8	141.63	131.84	133.9	130.52

B1. Which ARIMA models do you think will be appropriate in explaining sales of the product s100 and s70 respectively and why? (CO 3) 10 marks

B2. Forecast sales (for the month 13, 14, 15) using the most appropriate model (from B1) and calculate any measure of forecast error. To be forecasted/calculated for both products. (CO 4) (10 marks)

hint: historical sales and errors are reported below.

Date	bs100	bs70	Error# (bs100)	Error# (bs70)
05-2021	20	6	-	-
06-2021	15	16	-35.11	-13.21
07-2021	65	130	18.57	89.99
08-2021	59	133	-24.16	-30.09
09-2021	140	68	61.25	-98.33
10-2021	121	76	-17.24	-20.15
11-2021	78	26	-46.28	-78.79
12-2021	65	19	-27.70	-31.80
01-2022	30	45	-53.16	1.76
02-2022	55	89	-2.45	17.68
03-2022	145	157	69.19	38.18
04-2022	199	317	57.09	124.76

#error series are obtained from a model with one lag of the respective variables.

State assumptions, if any.