Assignment on Time Series Analysis & Forecasting

Course Instructor: Md. Siddikur Rahman, PhD

1. Below are the net sales in $ million for Home Depot, Inc. and its subsidiaries from 2015 to 2024.

Table 1: Net sales of different years

Year	Net Sales ($)	Year	Net Sales ($)
2015	50,600	2020	156,700
2016	67,300	2021	201,400
2017	80,800	2022	227,300
2018	98,100	2023	256,300
2019	124,400	2024	280,900

Note: **Add last three digits of your ID with Net Sales**

i) Determine the least square equation. Based on this information, what are the estimated sales for 2030?

ii) ii) Plot Net Sales and Trend Line

Solution:

Year(X)	Net Sales($)(Y)	XY	XX
2015	50600020	1.01959E+11	4060225
2016	67300020	1.35677E+11	4064256
2017	80800020	1.62974E+11	4068289
2018	98100020	1.97966E+11	4072324
2019	124400020	2.51164E+11	4076361
2020	156700020	3.16534E+11	4080400
2021	201400020	4.07029E+11	4084441
2022	227300020	4.59601E+11	4088484
2023	256300020	5.18495E+11	4092529
2024	280900020	5.68542E+11	4096576
20195	1543800200	3.11994E+12	40783885

$m = (n\sum xy - \sum y\sum x)/[n\sum x^2 - (\sum x)^2]$ Here, n=10; $\sum x$=20195; $\sum y$=1543800200

$\sum xy$ = 3.1199E+12;

$\sum x^2$ =40783885

$m= (10*3.1199E+12-1543800200*20195)/[10*40783885-20195^2]$

$= 3*10^7$

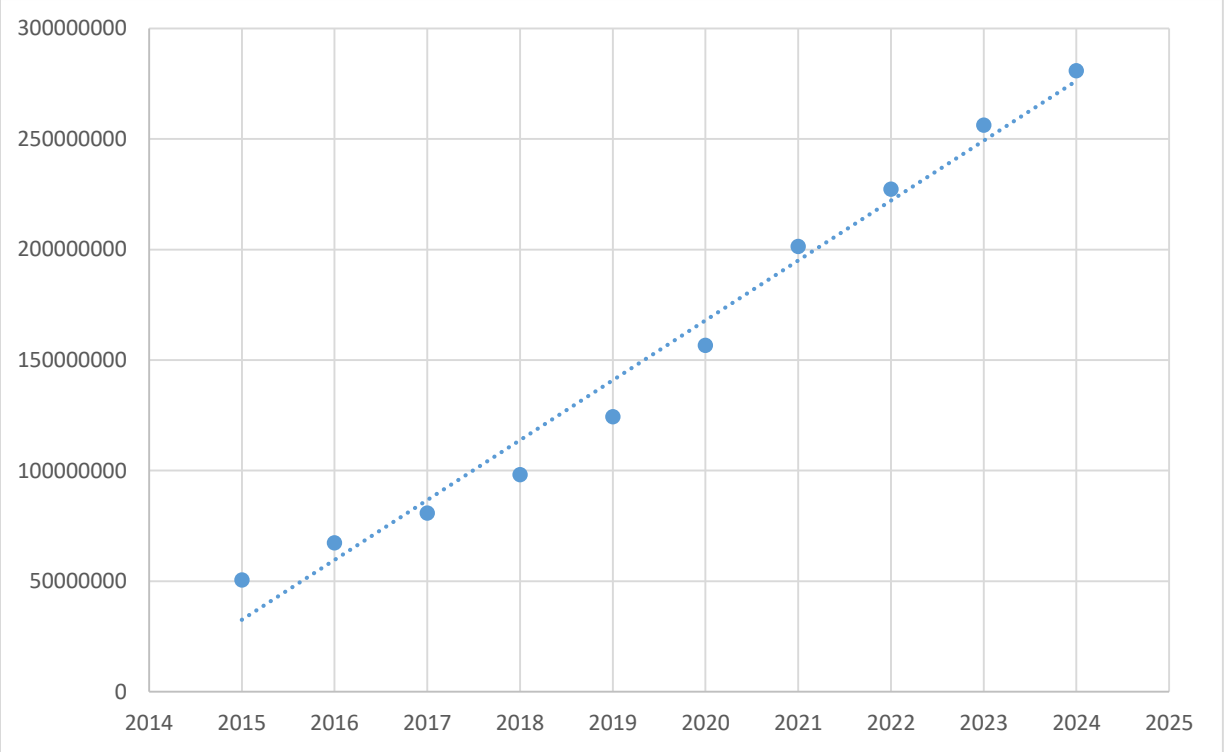
$b = (\sum y - m \sum x)/n$

$= (1543800200-3*10^7*20195)/10$

$= -5*10^{10}$

$y = 3*10^7x- 5*10^{10}$

For x=2030 we get $y = 1.09*10^{10}$ $



2. It appears that the imports of carbon black have been increasing by about 10 percent annually.

Table 2: Amount of Carbon Block imported in different years.

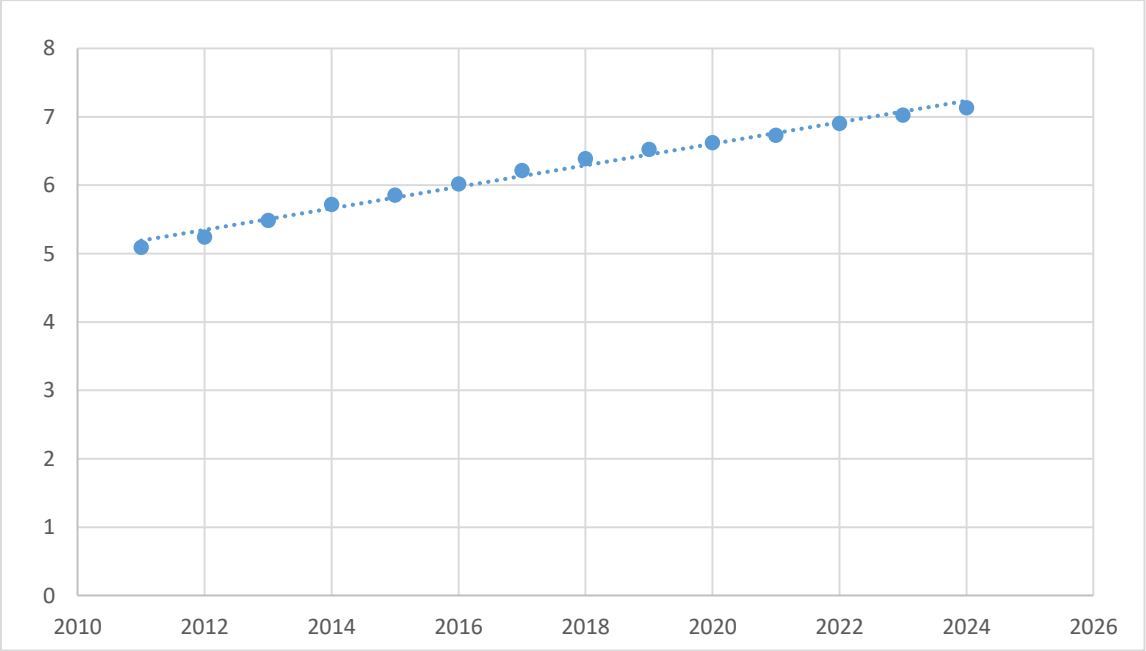
Year	Imports of Carbon Block (thousands of tons)	Year	Imports of Carbon Block (thousands of tons)
2011	124	2018	2463
2012	175	2019	3358
2013	306	2020	4181
2014	524	2021	5388
2015	714	2022	8027
2016	1052	2023	10587
2017	1638	2024	13537

Note: **Add last three digits of your ID with imports of Carbon Block**

i) Determine the logarithmic trend.
ii) Find the annual rate of increase.
iii) Estimate imports for the year 2030.

Solution:

Sl No	Year(X)	Imports of Carbon Block(Thousands of tons)(Y)	log(Y)
1	2011	124020	5.093492
2	2012	175020	5.243088
3	2013	306020	5.48575
4	2014	524020	5.719348
5	2015	714020	5.85371
6	2016	1052020	6.022024
7	2017	1638020	6.214319
8	2018	2463020	6.391468
9	2019	3358020	6.526083
10	2020	4181020	6.621282
11	2021	5388020	6.731429
12	2022	8027020	6.904554
13	2023	10587020	7.024774
14	2024	13537020	7.131523



Here slope, m is the annual rate of increase. Which is m = 0.1571

The logarithmic trend equation is,

Log(y) = 0.1571x – 310.71

For x = 2030 we get Log(y) = 8.203

Thus, Imports of Carbon Block (thousands of tons) in 2030 = 159587914.7

3. The quarterly production of pine lumber, in millions of board feet, by Northwest lumber since 2018 is:

Table 3: Productions in different quarters of several years

Year	Quarter	Production	Year	Production	Sales	Year	Quarter	Production
2018	Winter	90	2021	Winter	201	2024	Winter	265
	Spring	85		Spring	142		Spring	185
	Summer	56		Summer	110		Summer	142
	Fall	102		Fall	274		Fall	333
2019	Winter	115	2022	Winter	251	2025	Winter	282
	Spring	89		Spring	165		Spring	175
	Summer	61		Summer	125		Summer	157
	Fall	110		Fall	305		Fall	350
2020	Winter	165	2023	Winter	241	2024	Winter	290
	Spring	110		Spring	158		Spring	201
	Summer	98		Summer	132		Summer	187
	Fall	248		Fall	299		Fall	400

Note: **Add last three digits of your ID with number of Productions**

i) Develop a seasonal index for each quarter and interpret it.
ii) Project the production for 2030 and also find the base year production.
iii) Plot the original data, deseasonalize data, and interpret.

Solution:

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)	Mean
2018	90020	85020	56020	102020	83270
2019	115020	89020	61020	110020	93770
2020	165020	110020	98020	248020	155270
2021	201020	142020	110020	274020	181770
2022	251020	241020	165020	158020	203770
2023	125020	132020	305020	299020	215270
2024	265020	185020	142020	333020	231270
2025	282020	175020	157020	350020	241020
2026	290020	201020	187020	400020	269520

Seasonal Index calculation: Divide seasonal value of each year with the mean of each year. Then we get,

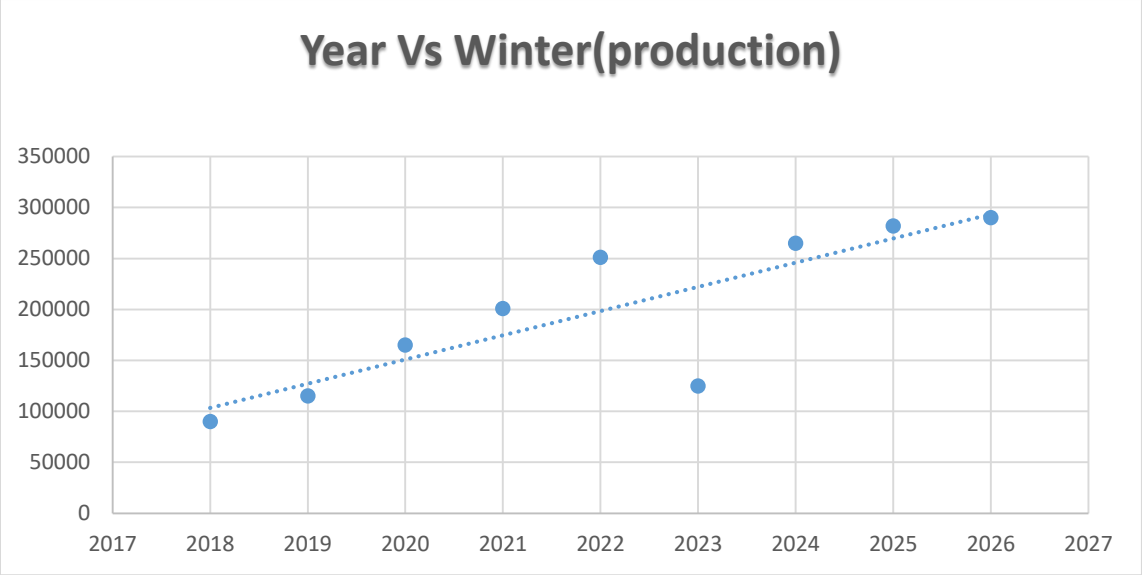
Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	1.0810	1.0210	0.6727	1.2251
2019	1.2266	0.9493	0.6507	1.1732
2020	1.0627	0.7085	0.6312	1.5973
2021	1.1059	0.7813	0.6052	1.5075
2022	1.1867	0.7801	0.5910	1.4420
2023	1.1614	0.7614	0.6361	1.4409
2024	1.1459	0.8000	0.6140	1.4399
2025	1.1701	0.7261	0.6514	1.4522
2026	1.0760	0.7458	0.6939	1.4841

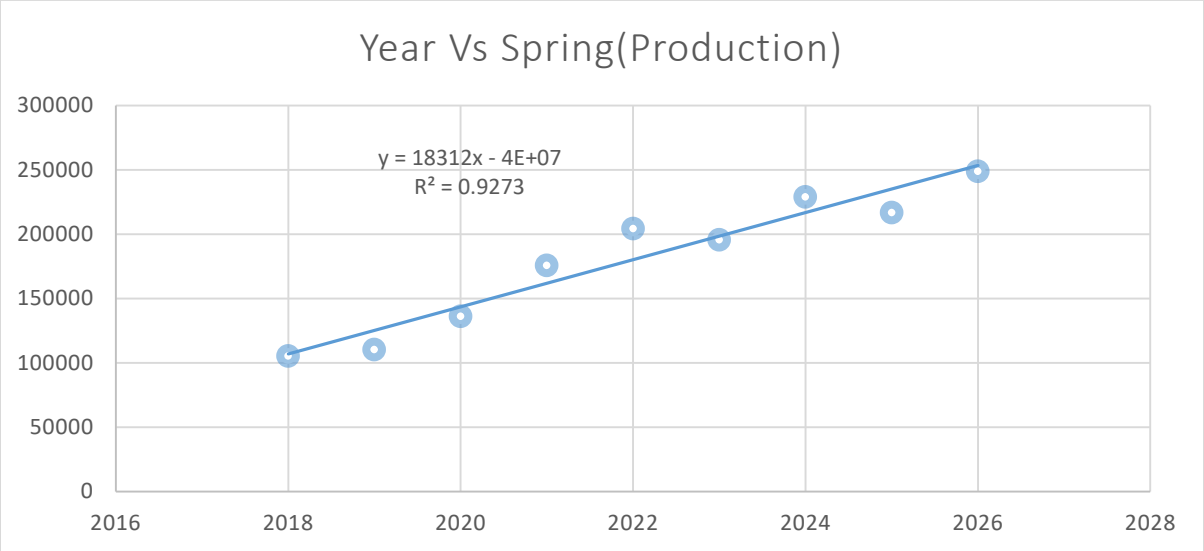
Overall Seasonal Index:

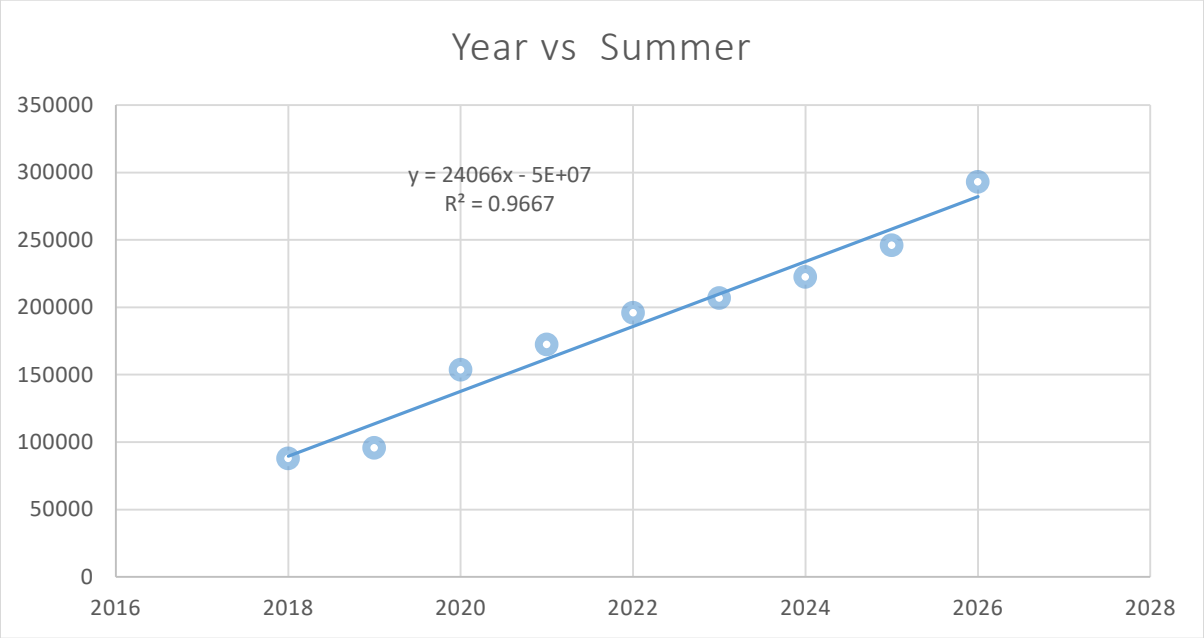
Seasonal Index	Winter	Spring	Summer	Fall
SI	1.1351	0.8082	0.6385	1.4180
Sum of SI	4			

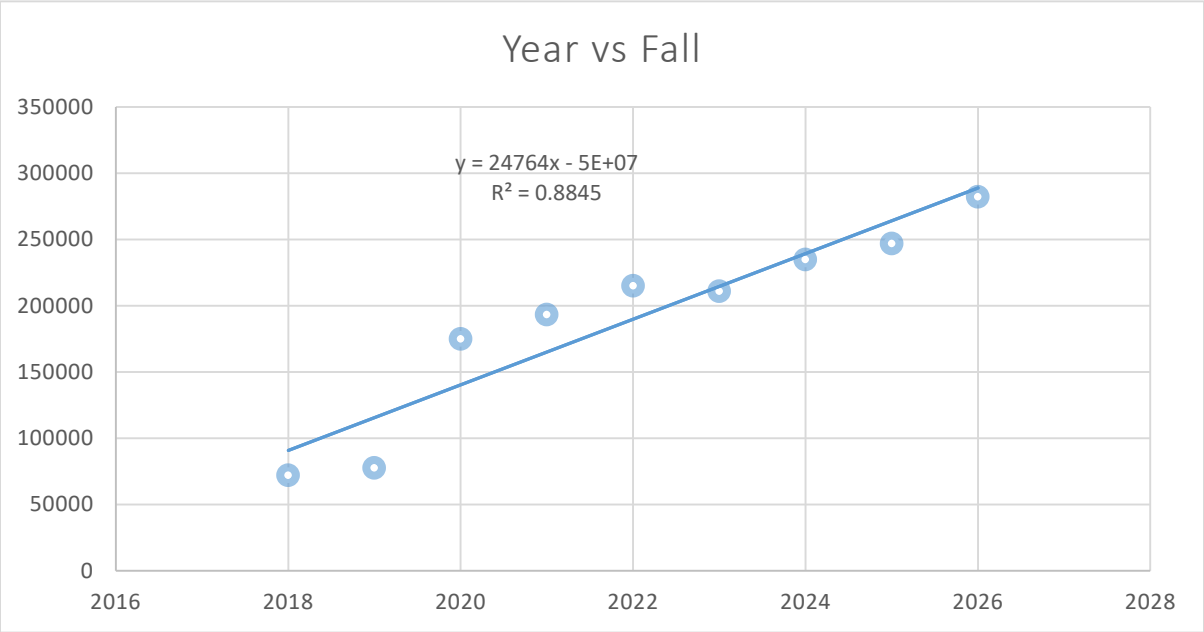
De-seasonalize data:

Year	Winter(production)	Spring(production)	Summer(production)	Fall(production)
2018	79302.74486	105198.5393	87736.78045	71945.01688
2019	101325.657	110147.7196	95567.20549	77586.4912
2020	145371.4813	136130.9162	153512.3508	174901.9233
2021	177084.4749	175724.3587	172305.3709	193236.7149
2022	221130.2992	204182.1454	195796.646	215097.4279
2023	212321.1343	195521.0799	206759.2411	210866.3221
2024	233463.13	228928.047	222420.0912	234842.588
2025	248438.7103	216555.0962	245911.3663	246830.7209
2026	255486.0422	248724.7682	292893.9166	282089.9355


Year Vs Winter(production)
350000
300000
250000
200000
150000
100000
50000
0
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027


Year Vs Spring(Production)
y = 18312x - 4E+07
R² = 0.9273
300000
250000
200000
150000
100000
50000
0
2016
2018
2020
2022
2024
2026
2028


Year vs Summer
y = 24066x - 5E+07
R² = 0.9667
350000
300000
250000
200000
150000
100000
50000
0
2016
2018
2020
2022
2024
2026
2028


Year vs Fall
y = 24764x - 5E+07
R² = 0.8845
350000
300000
250000
200000
150000
100000
50000
0
2016
2018
2020
2022
2024
2026
2028