

TIME-BASED DATA

1. (C) Seasonal variations
2. (B) 40, 42, 44
3. (a) $y_c = a + bx$
4. (A) $y_c = 14 + 1.54x$
5. (c) 22, 29, 35, 41
6. (B) I – b – iii; II – c – i; III – a – ii
7. (C) Secular trend variations
8. (c) 47, 55, 53
9. d) Irregular
10. (C) $\frac{a + c + d + e}{4}$
11. The

Year	Rain fall (in mm)	3 year moving total	3 year moving average	1 mark for 3- year moving totals + 1 mark for 3- year moving averages
2001	1.2	---	---	
2002	1.9	5.1	1.7	
2003	2	5.3	1.77	
2004	1.4	5.5	1.83	
2005	2.1	4.8	1.6	
2006	1.3	5.2	1.73	
2007	1.8	4.2	1.4	
2008	1.1	4.2	1.4	
2009	1.3	---		

12. Fit

Year	Production (Y)	Origin = 2004 (X)	X^2	XY
2001	30	– 3	9	–90
2002	35	– 2	4	–70
2003	36	– 1	1	–36
2004	32	0	0	0
2005	37	1	1	37
2006	40	2	4	80
2007	36	3	9	108
2009	$\Sigma Y = 246$	$\Sigma XY = 0$	$\Sigma X^2 = 28$	$\Sigma XY = 29$

[1]

Trend equation is $Y_C = a + bX$; and

Normal equations are:

$$\left. \begin{aligned} a &= \frac{\Sigma Y}{n} = \frac{246}{7} = 35.14 ; \text{ and} \\ b &= \frac{\Sigma XY}{\Sigma X^2} = \frac{29}{28} = 1.03 \end{aligned} \right\} \quad [1]$$

$$\Rightarrow \text{Trend equation is } Y_C = 35.14 + 1.03 X \quad \left[\frac{1}{2} \right]$$

$$\text{Thus, trend value for 2008 is } [35.14 + 1.03(4)] = 39.26 \quad \left[\frac{1}{2} \right]$$

13. Find
Ans

Year	Production	Five yearly moving total	Five yearly moving averages
2012	16	-	-
2013	14	-	-
2014	20	16+14+20+18+22=90	90/5=18
2015	18	14+20+18+22+17=91	91/5=18.2
2016	22	20+18+22+17+19=96	96/5=19.2
2017	17	18+22+17+19+21=97	97/5=19.4
2018	19	22+17+19+21+20=99	99/5=19.8
2019	21	-	-
2020	20	-	-

1 mark each
for the 3rd
and 4th
column

Hence the trend values are 18. 18.2. 19.2. 19.4. 19.8

14. For
15. Find

Year	Y	3 yearly moving total	3 yearly moving average(Trend) (in ₹ lakh)
2016	25	---	---
2017	30	87	29
2018	32	102	34
2019	40	117	39
2020	45	135	45
2021	50	---	---

1M for
3-yearly
moving
totals

1M for
3-yearly
moving
average

16. Given

Ans

Year (x_i)	Index number (Y)	$X = x_i - A$ $= x_i - 2018$	X^2	XY
2016	160	-2	4	-320
2017	185	-1	1	-185
2018	220	0	0	0
2019	300	1	1	300
2020	510	2	4	1020
$n = 5$	$\sum Y = 1375$	$\sum X = 0$	$\sum X^2 = 10$	$\sum XY = 815$

1 mark for the correct table

$$\text{Now, } a = \frac{\sum Y}{n} = \frac{1375}{5} = 275 \text{ and } b = \frac{\sum XY}{\sum X^2} = \frac{815}{10} = 81.5$$

Thus the required equation of the best fitted trend line is

$$y = a + bx \Rightarrow y = 275 + 81.5x$$

Trend values are :

$$2016 \rightarrow 275 + 81.5(-2) = 112$$

$$2017 \rightarrow 275 + 81.5(-1) = 193.5$$

$$2018 \rightarrow 275 + 81.5(0) = 275$$

$$2019 \rightarrow 275 + 81.5(1) = 356.5$$

$$2020 \rightarrow 275 + 81.5(2) = 438$$

1

1

17. Fit

18. The

Year	Quarters	Y	4-Quarterly Moving Total	4 Quarterly Moving average (Centered) (in ₹crore)
2018	Q_1	12	64	--
	Q_2	14		--
	Q_3	18		16.75
	Q_4	20		17.75
2019	Q_1	18	72	18.25
	Q_2	16	74	18.75
	Q_3	20	76	20.125
	Q_4	22	85	22.25
2020	Q_1	27	93	24.50
	Q_2	24	103	27.5
	Q_3	30	117	--
	Q_4	36		--

$1\frac{1}{2}$ for 4 quarterly moving totals

$1\frac{1}{2}$ for 4 Quarterly moving average (Centered)

19. Fit a

Year	Y	X = Year - 2017	X^2	XY
2014	26	-3	9	-78
2015	26	-2	4	-52
2016	44	-1	1	-44
2017	42	0	0	0
2018	108	1	1	108
2019	120	2	4	240
2020	166	3	9	498
$\sum Y = 532$		$\sum X^2 = 28$		$\sum XY = 672$

$$a = \frac{\sum Y}{n} = \frac{532}{7} = 76, \quad b = \frac{\sum XY}{\sum X^2} = \frac{672}{28} = 24$$

$$Y_c = a + bX, \quad Y_c = 76 + 24X$$

$$\text{Estimated sales} = Y_c \text{ for } 2023 = 76 + 24 \times 6 = ₹220 \text{ lacs}$$

1

1

1

20. Compute
Sol.

Year	Index Number	4 yearly moving total	4 yearly moving Average	Centered Total	Centered moving average
2001	2450				
2002	1470				
		7870	1967.5		
2003	2150			3625	1812.5
		6630	1657.5		
2004	1800			3435	1717.5
		7110	1777.5		
2005	1210			3592.5	1796.25
		7260	1815		
2006	1950			3805	1902.5
		7960	1990		
2007	2300			4297.5	2148.75
		9230	2307.5		
2008	2500			4797.5	2398.75
		9960	2490		
2009	2480				
2010	2680				

4 yearly
moving
total – 1
mark

4 yearly
moving
average
– 1½
marks

centered
total - 1
mark

centered
moving
average
- 1½
marks

21. Fit a

Year (x_i)	Index Number (Y)	$X = \frac{x_i - A}{0.5}$ $= \frac{x_i - 2013.5}{0.5}$	X^2	XY	$Y_t = a + bx$
2011	210	-5	25	-1050	234.17 + (-5)1.64 = 225.97
2012	225	-3	9	-675	229.25
2013	275	-1	1	-275	232.53
2014	220	1	1	220	235.81
2015	240	3	9	720	239.09
2016	235	5	25	1175	242.37
$n = 6$	1405	$\sum X = 0$	$\sum X^2 = 70$	$\sum XY = 115$	

2½ for
the
correct
table

$$a = \frac{\sum Y}{n} = \frac{1405}{6} = 234.17 \text{ (approx.)}$$

1

$$b = \frac{\sum XY}{\sum X^2} = \frac{115}{70} = 1.64 \text{ (approx.)}$$

1

Required line is $Y = a + bx = 234.17 + 1.64x$

½

22. Fit a

Sol.

Consider year 2014 as the year of origin. Calculation of trend values by method of least squares.

Year	Sales (in lakh ₹) y	Deviations from 2014 (x)	Squares of Deviations (x^2)	Sales deviation (xy)
2010	65	-4	16	-260
2012	68	-2	4	-136
2013	70	-1	1	-70

2014	72	0	0	0
2015	75	1	1	75
2016	67	2	4	134
2019	73	5	25	365
$n = 7$	$\sum y = 490$	$\sum x = 1$	$\sum x^2 = 51$	$\sum xy = 108$

(2 for
correct
table)

The equation of the straight-line trend is

$$y_c = a + bx$$

Two normal equations are

$$\Sigma y = na + b\Sigma x$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

$$\Rightarrow 490 = 7a + b \text{ and } 108 = a + 51b$$

$$\Rightarrow a = 69.9 \text{ and } b = 0.75$$

$$y_c = 69.9 + 0.75x$$

Thus, trend values are

$$y_{2010} = 69.9 + 0.75(-4) = 66.90$$

$$y_{2012} = 69.9 + 0.75(-2) = 68.40$$

$$y_{2013} = 69.9 + 0.75(-1) = 69.15$$

$$y_{2014} = 69.9 + 0.75(0) = 69.90$$

$$y_{2015} = 69.9 + 0.75(1) = 70.65$$

$$y_{2016} = 69.9 + 0.75(2) = 71.40$$

(1)

(1)

(1 for
correct
trend
values)

**23. Fit a
Sol.**

Year	Index Number (Y)	$X = x_i - A$ $= x_i - 2014$	X^2	XY	$Y_t = a + bX$
2010	65	-4	16	-260	69.75 $+ (-4)0.75$ $= 66.75$
2012	68	-2	4	-136	68.25
2013	70	-1	1	-70	69
2014	72	0	0	0	69.75
2015	75	1	1	75	70.5
2016	67	2	4	134	71.25
2019	73	5	25	365	73.5
$n = 7$	$\sum Y = 490$	$\sum X = 1$	$\sum X^2 = 51$	$\sum XY = 108$	

**2½ for
the
correct
table**

Equation of trend line is $Y = a + bX$

$\sum Y = na + b \sum X$ and $\sum XY = a \sum X + b \sum X^2$

**24. Fin
Sol.**

Year	Sales	4 yearly moving total	4 yearly moving Average	Centered moving average
2015	108			
2016	112			
		450	112.5	
2017	110			116.5
		482	120.5	
2018	120			121.5
		490	122.5	
2019	140			121.25
		480	120	
2020	120			121.875
		495	123.75	
2021	100			
2022	135			

4 yearly
moving
total: **1½
marks**

4 yearly
moving
average:
**1½
marks**

centered
moving
average:
2 marks

25. The
Take 2019 as the middle year, i.e., $A = 2019$

Year (x_i)	Rice Production (million tonnes) (Y)	$X = x_i - A$	X^2	XY	Trend Values $Y = a + bX$
2017	9.5	-2	4	-19.0	9.40
2018	10.0	-1	1	-10.0	10.02
2019	10.5	0	0	0.0	10.64
2020	11.2	1	1	11.2	11.26
2021	12.0	2	4	24.0	11.88
Total	53.2	0	10	6.2	

$$a = \frac{\sum Y}{n} = \frac{53.2}{5} = 10.64$$

$$b = \frac{\sum XY}{\sum X^2} = \frac{6.2}{10} = 0.62$$

∴ The trend equation is $y = 10.64 + 0.62x$

For the year 2025; $y = 10.64 + 0.62(6) = 14.36$ million tonnes

26. The

Month	Number of vehicles (Thousands)	3-Month Moving Total	3-Month Moving Average
March	30	-	-
April	35	103	34.33
May	38	109	36.33
June	36	114	38.00
July	40	118	39.33
August	42	121	40.33
September	39	126	42.00
October	45	132	44.00
November	48	140	46.67
December	47	-	-

Correct graph

3
marks
for
correct
table

½

½

½

½

3
marks
for
correct
table

2

27. Fit a

Here, number of observations $n = 11$ (odd number)

Year (t)	Production (y)	$x = t_i - 1967$	x^2	xy
1962	2	-5	25	-10
1963	4	-4	16	-16
1964	3	-3	9	-9
1965	4	-2	4	-8
1966	4	-1	1	-4
1967	2	0	0	0
1968	4	1	1	4
1969	9	2	4	18
1970	7	3	9	21
1971	10	4	16	40
1972	8	5	25	40
Total	$\sum y = 57$	$\sum x = 0$	$\sum x^2 = 110$	$\sum xy = 76$

2 marks
for
correct
table

Year 1967 is taken as year of origin.

The normal equations are $\sum y = na + b\sum x$ and $\sum xy = a\sum x + b\sum x^2$

Since, $\sum x = 0$ i.e., deviation from actual mean is zero,

$$\text{we have } a = \frac{\sum y}{n} = \frac{57}{11} = 5.18, b = \frac{\sum xy}{\sum x^2} = \frac{76}{110} = 0.69$$

Therefore, the required equation of the trend line $y = 5.18 + 0.69x$

1

The trend values are

1.73, 2.42, 3.11, 3.8, 4.49, 5.18, 5.87, 6.56, 7.25, 7.94, 8.63

2

28. The

Yearly/ Quarterly	Small scale industry	4-quarterly moving total	4-quarterly moving average	4-year centered moving average
I	39			

2020	II	47	162	40.5	
	III	20	191	47.75	44.125
	IV	56	203	50.75	49.25
2021	I	68	249	62.25	56.5
	II	59	265	66.25	64.25
	III	66	285	71.25	68.75
	IV	72	286	71.5	71.375
2022	I	88	280	70.00	70.75
	II	60	275	68.75	69.375
	III	60			
	IV	67			

1½
marks
each for
3rd and
4th
column

2 marks
for last
column

29. When
Sol.

(i)

Year (x_i)	Index Number (y)	$x = \frac{x_i - A}{0.5}$	x^2	xy
1996	6.5	-5	25	-32.5
1997	5.3	-3	9	-15.9
1998	4.3	-1	1	-4.3
1999	6.1	1	1	6.1
2000	5.6	3	9	16.8
2001	7.8	5	25	39
n = 6	$\sum y = 35.6$	$\sum x = 0$	$\sum x^2 = 70$	$\sum xy = 9.2$

(1) for
correct
table

$$a = \frac{\sum y}{n} = \frac{35.6}{6}, b = \frac{\sum xy}{\sum x^2} = \frac{9.2}{70} = 0.13$$

∴ Equation of straight-line trend is given by

$$y = a + bx = 5.9 + 0.13x$$

(½)

(½)

(ii) (a) Trend Values

1996	$5 \cdot 9 + (-5) \times 0 \cdot 13 = 5 \cdot 25$
1997	$5 \cdot 9 + (-3) \times 0 \cdot 13 = 5 \cdot 51$
1998	$5 \cdot 9 + (-1) \times 0 \cdot 13 = 5 \cdot 77$
1999	$5 \cdot 9 + (1) \times 0 \cdot 13 = 6 \cdot 03$
2000	$5 \cdot 9 + (3) \times 0 \cdot 13 = 6 \cdot 29$
2001	$5 \cdot 9 + (5) \times 0 \cdot 13 = 6 \cdot 55$

Expected sales trend for 2002

$$= 5.9 + 0.13 \left(\frac{2002 - 1998.5}{0.5} \right)$$

= ₹ 6.81 lakhs

OR

Year (x_i)	Profit (y)	$x = x_i - A$	x^2	xy
2004	114	-3	9	-342
2005	130	-2	4	-260
2006	126	-1	1	-126
2007	144	0	0	0
2008	138	1	1	138
2009	156	2	4	312
2010	164	3	9	492
$n = 7$	$\sum y = 972$	$\sum x = 0$	$\sum x^2 = 28$	$\sum xy = 214$

$$a = \frac{\sum y}{n} = \frac{972}{7} = 138.86, b = \frac{\sum xy}{\sum x^2} = \frac{214}{28} = 7.64$$

So, required equation of straight-line trend is

$$y = a + bx = 138.86 + 7.64x$$

(1)
mark
for
correct
trend
values

$\left(\frac{1}{2}\right)$

$\left(\frac{1}{2}\right)$

(1) for
correct
table

$\left(\frac{1}{2}\right)$

$\left(\frac{1}{2}\right)$

30. The
Ans.

(a)

y	x	x²	xy
3	-2	4	-6
6	-1	1	-6
9	0	0	0
16	1	1	16
24	2	4	48
$\sum y = 58$		$\sum x^2 = 10$	$\sum xy = 52$

1½

Trend value is $y = \frac{\sum y}{5} + \frac{\sum xy}{\sum x^2} x$
 $y = 11.6 + 5.2 x$

½

OR

y	x	x²	xy
9	-2	4	-18
18	-1	1	-18
21	0	0	0
29	1	1	29
38	2	4	76
$\sum y = 115$		$\sum x^2 = 10$	$\sum xy = 69$

1½

Trend value is $y = \frac{115}{5} + \frac{69}{10} x$
 $y = 23 + 6.9 x$

½

(b) For $x = 3$, we have

$$y = 23 + 6.9 (3) = 43.7$$

1

(c) For $x = 3$, we have

$$y = 11.6 + 5.2 (3) = 27.2$$

1

31. When

Year	Y	X=Year - 2003	X ²	XY
2001	160	-2	4	-320
2002	185	-1	1	-185
2003	220	0	0	0
2004	300	1	1	300
2005	510	2	4	1020
	1375		10	815

2 Marks for table

$$a = \frac{\sum Y}{n} = \frac{1375}{5} = 275$$

½ Mark

$$b = \frac{\sum XY}{\sum X^2} = \frac{815}{10} = 81.5$$

½ Mark

$$Y_c = a + bX$$

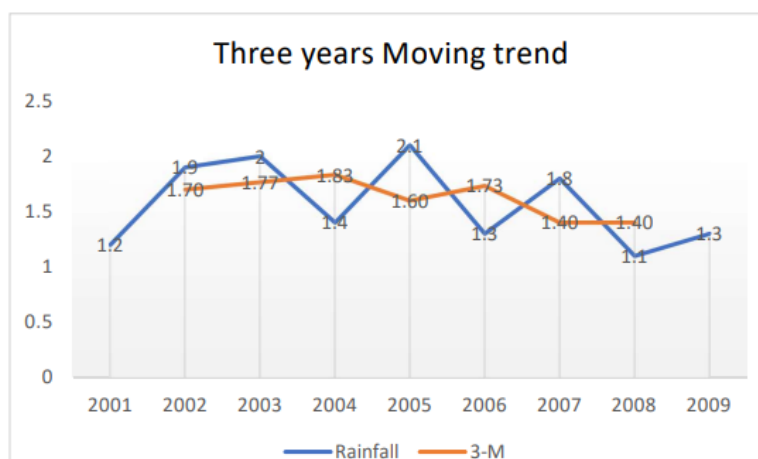
$$Y_c = 275 + 81.5 X$$

The estimated value for 2008 will be $275 + 81.5 \times 5 = 275 + 407.5 = 682.5$ 1 Mark

32. The

Year	Rainfall(in cm)	3 years moving total	3 years moving average
2001	1.2		
2002	1.9	5.1	1.70
2003	2	5.3	1.77
2004	1.4	5.5	1.83
2005	2.1	4.8	1.60
2006	1.3	5.2	1.73
2007	1.8	4.2	1.40
2008	1.1	4.2	1.40
2009	1.3		

1½ Marks for table



33. When

a)

Year	Y	X	X ²	XY
2015	35	-2	4	-70
2016	42	-1	1	-42
2017	46	0	0	0
2018	41	1	1	41
2019	48	2	4	96
	212		10	25

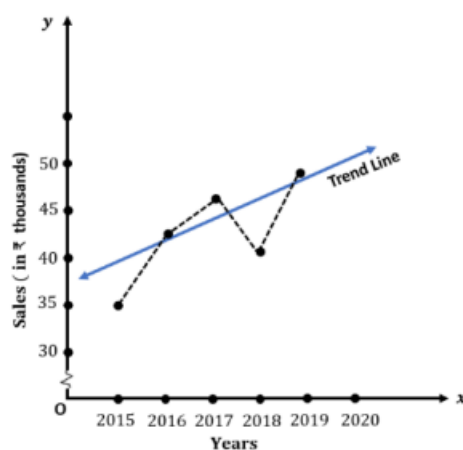
$$a = \frac{\sum Y}{n} = \frac{212}{5} = 42.4 \text{ and } b = \frac{\sum XY}{\sum X^2} = \frac{25}{10} = 2.5$$

$$Y_c = 42.4 + 2.5X$$

2

OR

Year	Y	3-year moving average
2015	35	-
2016	42	41
2017	46	43
2018	41	45
2019	48	-



b) For year 2022,

$$Y_{2022} = 42.4 + 2.5(2022 - 2017) = 54.9$$

⇒ the estimated sales for year 2022 = ₹ 54,900

1

c)

$$Y_c = 42.4 + 2.5X$$

$$\Rightarrow 67.4 = 42.4 + 2.5X$$

$$\Rightarrow X = 10$$

Sales will be ₹ 67,400 in year (2017+ 10) = year 2027

1