20/4/23 **Practical No - 10**

Aim - To prepare price and quantity index numbers using different methods

Problem - Prepare price and quantity index numbers for 2005 with 2000 as base year for the following data by using (i) Laspeyre's (ii) Paasche's (iii) Marshall - Edgeworth and (iv) Fisher's method

Year	Article I		Article II		Article III		Article IV	
	Price	Qty	Price	Qty	Price	Qty	Price	Qty
2002	5.00	5	7.75	6	9.63	4	12.50	9
2005	6.50	7	8.80	10	7.75	6	12.75	9

Theory and formula -

The formula's for price and quantity index no. are given by -

(i) Laspeyre's method -

$$P_{oi}^{La} = \frac{\Sigma p_{ij} q_{oj}}{\Sigma p_{oj} q_{oj}} \times 100 \quad , \quad Q_{oi}^{La} = \frac{\Sigma q_{ij} p_{oj}}{\Sigma q_{oj} p_{oj}} \times 100$$

(ii) Paasche's method -

$$P_{oi}^{Pa} = \frac{\Sigma p_{ij} q_{ij}}{\Sigma p_{oj} q_{oj}} \times 100 \quad , \quad Q_{oi}^{Pa} = \frac{\Sigma q_{ij} p_{ij}}{\Sigma q_{oj} p_{ij}} \times 100$$

(iii) Marshall - Edgeworth method -

$$P_{oi}^{ME} = \frac{\Sigma p_{ij} (q_{oj} + q_{ij})}{\Sigma p_{oj} (q_{oj} + q_{ij})} \times 100$$

$$Q_{oi}^{ME} = \frac{\Sigma q_{ij} (p_{oj} + p_{ij})}{\Sigma q_{oj} (p_{oj} + p_{ij})} \times 100$$

(iv) Fisher's method -

$$P_{oi}^{F} = (P_{oi}^{La} \times P_{oi}^{Pa})^{1/2} \quad , \quad Q_{oi}^{F} = (Q_{oi}^{La} \times Q_{oi}^{Pa})^{1/2}$$

Calculation -

Article	2002		2005		P_iq_0	P_0q_0	P_iq_i	P_0q_i
	P_0	q_0	P_i	q_i				
I	5.00	5	6.50	7	32.50	25.00	45.50	35.00
II	7.75	6	8.80	10	52.80	46.50	88.00	77.50
III	9.63	4	7.75	6	31.00	38.52	46.50	57.78
IV	12.50	9	12.75	9	114.75	112.50	114.75	112.50
Total					231.05	222.52	294.75	282.78

$$P_{0i}^{La} = \frac{\Sigma P_{ij} q_{0j}}{\Sigma P_{0j} q_{0j}} \times 100 = \frac{231.05}{222.52} \times 100 = 103.8$$

$$Q_{0i}^{La} = \frac{\Sigma q_{ij} P_{0j}}{\Sigma q_{0j} P_{0j}} \times 100 = \frac{282.78}{222.52} \times 100 = 127.8$$

$$P_{0i}^{Pa} = \frac{\Sigma P_{ij} q_{ij}}{\Sigma P_{0j} q_{ij}} \times 100 = \frac{294.75}{282.78} \times 100 = 104.23$$

$$Q_{0i}^{Pa} = \frac{\Sigma q_{ij} P_{ij}}{\Sigma P_{0j} P_{ij}} \times 100 = \frac{294.75}{231.05} \times 100 = 127.57$$

$$P_{0i}^{ME} = \frac{\Sigma (P_{ij} q_{0j} + P_{ij} q_{ij})}{\Sigma (P_{0j} q_{0j} + P_{0j} q_{ij})} \times 100 = \frac{231.05 + 294.75}{222.52 + 282.78} \times 100$$

$$= \frac{525.8}{505.3} \times 100$$

$$= 104.056.$$

$$Q_{0i}^{ME} = \frac{\Sigma (q_{ij} P_{0j} + q_{ij} P_{ij})}{\Sigma (q_{0j} P_{0j} + q_{0j} P_{ij})} \times 100 = \frac{282.78 + 294.75}{222.52 + 231.05} \times 100$$

$$= \frac{57753}{453.57} \times 100$$

$$= 127.32$$

$$P_{oi}^{F} = (P_{oi}^{La} \times P_{oi}^{Pa})^{1/2}$$

$$= \left(\frac{231.05}{222.52} \times \frac{294.75}{282.78}\right)^{1/2} \times 100 = 104.1$$

$$Q_{oi}^{F} = (Q_{oi}^{La} \times Q_{oi}^{Pa})^{1/2}$$

$$= \left(\frac{282.78}{222.52} \times \frac{294.75}{231.05}\right)^{1/2} \times 100 = 127.24$$

Results -

Method	Price Index no.	Quantity Index no.
Laspeyre's	103.8	127.8
Paasche's	104.23	127.57
Marshall - Edgeworth's	104.056	127.23.
Fisher's	104.1	127.24

Aim- To verify that Factor Reversal test and time reversal test are satisfied by Fisher's formula

Problem- By using data from practical-10, verify if the Fisher's formula satisfies Factor and Time Reversal test.

Theory and formula -

Fischer's price index no. - $\left(\frac{\Sigma P_{ij} q_{0j}}{\Sigma P_{0j} q_{0j}} \times \frac{\Sigma P_{ij} q_{ij}}{\Sigma P_{0j} q_{ij}}\right)^{1/2} \times 100$

Fisher's quantity index no. - $\left(\frac{\Sigma q_{ij} P_{0j}}{\Sigma q_{0j} P_{0j}} \times \frac{\Sigma q_{ij} P_{ij}}{\Sigma P_{0j} P_{ij}}\right)^{1/2} \times 100$

Time Reversal Test -

If the time script of any index formula be interchanged, then the resulting index should be reciprocal of original index

$$P_{ii'} = \frac{1}{P_{i'i}} \Rightarrow P_{ii'} \times P_{i'i} = 1.$$

$$\Rightarrow P_{0i}^{F} \times P_{i0}^{F} = 1.$$

Factor Reversal Test -

The formula of index no. should ought to permit the interchanging of price and quantities without giving inconsistent results. Two results multiplied together should give true value ratio except for constant of proportionality

$$P_{0i} \times Q_{0i} = \frac{\Sigma V_{ij}}{\Sigma V_{0j}} = \frac{\Sigma P_{ij} q_{ij}}{\Sigma P_{0j} q_{0j}}$$

Calculation -

$$P_{0i}^{F} \times P_{i0}^{F} = \left(\frac{\Sigma P_{ij} q_{0j}}{\Sigma P_{0j} q_{0j}} \times \frac{\Sigma P_{ij} q_{ij}}{\Sigma P_{0j} q_{ij}}\right)^{1/2} \times \left(\frac{\Sigma P_{0j} q_{ij}}{\Sigma P_{ij} q_{ij}} \times \frac{\Sigma P_{0j} q_{0j}}{\Sigma P_{ij} q_{0j}}\right)^{1/2}$$

$$= \left(\frac{231.05}{222.52} \times \frac{294.75}{282.78} \times \frac{282.78}{294.75} \times \frac{222.52}{231.05}\right)^{1/2} = 1.$$

⇒ Fisher's index no. satisfies Time Reversal test

$$P_{01}^{F} \times Q_{01}^{F} = \left(\frac{\Sigma P_{1j} q_{0j}}{\Sigma P_{0j} q_{0j}} \times \frac{\Sigma P_{1j} q_{1j}}{\Sigma P_{0j} q_{1j}}\right)^{1/2} \times \left(\frac{\Sigma q_{1j} p_{0j}}{\Sigma q_{0j} p_{0j}} \times \frac{\Sigma q_{1j} p_{1j}}{\Sigma q_{0j} p_{1j}}\right)^{1/2}$$

$$= \left(\frac{231.05}{222.52} \times \frac{294.75}{282.78} \times \frac{282.78}{222.52} \times \frac{294.75}{231.05}\right)^{1/2}$$

$$= \frac{294.75}{222.52} = \frac{\Sigma P_{1j} q_{1j}}{\Sigma P_{0j} q_{0j}} = V_{01}$$

⇒ Fisher's index no. satisfies Factor Reversal test

Result- Fisher's ideal index no. satisfies both time reversal tests and factor reversal tests.

Aim - To construct cost of living index number

Problem - For the data, construct the cost of living index for the year 2005 (Base 2001 = 100) using method of weighted price relative

Item	Unit	Price (in Rs)		
		2001	2005	weight
A	kg	50	75	10%
B	Litre	60	75	25%
C	Dozen	200	240	20%
D	kg	80	100	40%
E	one pair	160	200	5%

Theory and formula -

Price relative, $P_{oi} = \frac{\Sigma P_{ij}}{\Sigma P_{oj}} \times 100$

where P_{ij} is price of jth commodity in current year and P_{oj} is price of jth commodity in base year

The cost of living index no by method of weighted price relative is given by $CPI = \frac{\Sigma P_i w_i}{\Sigma w_i}$

where, w_i is weight of respective commodity

Calculation -

Item	Price 2001	Price 2005	Relative price $P = P_i / P_o$	weight w	Pw
A	50	75	$75/50 \times 100 = 150$	10	1500
B	60	75	125	25	3125
C	200	240	120	20	2400
D	80	100	125	40	5000
E	160	200	125	5	625
				100	12,650

cost of living index no. $= \frac{\Sigma PW}{\Sigma W} = \frac{12650}{100} = 126.50$

Result -

The cost of living index by using method of weighted price relative is 126.50

Aim - To construct the cost of living index no.

Problem - From the given data below, calculate the cost of living index no. for the current year by aggregate expenditure method -

Article	Quantity consumed in base year (quintals)	Unit	Price (in 100 Rs) per unit	
			Base year	current year
Rice	5	Quintal	60	80
Millet	5	Quintal	40	50
Wheat	1	Quintal	50	100
Gram	½	Quintal	30	60
Arhar	½	Quintal	40	60
Other pulse	2	Quintal	30	40
Ghee	4	kg	12.5	20
Gur	2	Quintal	25	50
Salt	12½	kg	40	50
Oil	24	kg	200	250
Clothing	40	metre	2.5	5
Firewood	10	Quintal	5	8
Kerosene	1 tin	Tin	40	60
House rent	-	-	120	150

Theory / Formula - In this data, we are given quantity consumed in base year according to each commodities, so this quantity is considered as weighted and denote by q_0 and also price of each commodities is given according to base and current year.

Then, the cost of living index for current year is given by the method of expenditure is

$$= \frac{\Sigma P_j q_{0j}}{\Sigma P_{oj} q_{oj}} \times 100 = \frac{\Sigma P_i q_0}{\Sigma P_0 q_0} \times 100 = \frac{\Sigma P \omega}{\Sigma \omega}$$

Calculation -

Article	Quantity unit (q_0)	Price		Aggregate expenditure	
		Base year (P_0)	Current year (P_i)	Base ($P_0 q_0$)	Current ($P_i q_0$)
				300	400
				200	250
				50	100
				30	60
				20	30
				60	80
				50	80
				50	100
				400	625
				4800	6000
				100	2000
				50	80
				40	60
				120	160
				6370	8215

Cost of living index for current year

$$= \frac{\Sigma P_i q_0}{\Sigma P_0 q_0} \times 100 = \frac{8215}{6370} \times 100 = 128.9$$

Result -

Cost of living index by aggregate method = 128.9

23/4/23 Practical No.-14

Aim - To construct the consumer price index for the current year and also find out the allowance required to maintain his former standard of living

Problem - An enquiry into the budgets of the middle class families of certain city revealed that on average the percentage expenses on the different groups were food 45, rent 15, clothing 12, fuel 8, light 8 and miscellaneous 20. The group index group number for the current year as compared with a fixed base period were respectively 410, 150, 343, 248, 285

Calculate the consumer price index no. for the current year Mr. X was getting Rs. 24000 p.m. in base period and Rs 43000 in the current year. State how much he ought to have recieved as extra allowance.

Theory and formula -

For the given data, we have percentage expenses on the different groups of commodities and we are also given that their group index no for given year

So, in this case CPI is calculated by $= \frac{\Sigma IW}{\Sigma W}$

where, I is the group index no. for the given year with commodities and W are percentage expenses of different commodities

The above given CPI no. reveal the purchasing power of current year.

To calculate the allowance to maintain the same std of living as in the base year is given in calculation part

Calculation -

Group	Group Index (I)	% Expenses (W)	(IW)
Food	410	45	18450
Rent	150	15	2250
Cloth	343	12	4116
Fuel and light	248	8	1984
Miscellaneous	285	20	5700

Consumer price index no $= \frac{\Sigma IW}{\Sigma W} = \frac{32,500}{100} = 325$

This say that purchasing power of Rs 325 in the current year is equal to Rs 100 in base year

Thus the person receiving Rs 24000 PM in base year should have $\frac{325}{100} \times 24000 = 78000$ pm in current year

∴ Mr X to maintain the same std of living as in base year = Rs (78000 - 43000)

= Rs, 35000 pm

Result -

Consumer price index no. = 325

Standard of living maintain Rs 35000

The CPI = 325 means that purchasing power of Rs 325 in current year is equal that of Rs 100 in base year.

To maintain same living std. required extra allowance Rs 35000 per month

23/4/23 Practical NO. 15 39

Aim - To solve the question on double sampling

Experiment - Plot AOQ, ATI, ASN and OC curves for a double sampling plan given $N = 500$, $n_1 = 50$, $n_2 = 100$, $c_1 = 2$ and $c_2 = 6$ using Poisson dist., where incoming quality p is given by

p = 0.01, 0.02, 0.03, 0.05, 0.06, 0.07, 0.08, 0.09, 0.10, 0.15, 0.2, 0.25, 0.30

Theory -

$$P_{a_1}(p) = \sum_{x=0}^{c_1} e^{-\lambda_1} \frac{\lambda_1^x}{x!}, \quad \lambda_1 = n_1 p$$

$$P_{a_2}(p) = \sum_{x=c_1+1}^{c_2} \sum_{y=0}^{c_2 - x} e^{-\lambda_1} \frac{\lambda_1^x}{x!} \cdot e^{-\lambda_2} \frac{\lambda_2^x}{y!}, \quad \lambda_2 = n_2 p$$

$$P_a(p) = P_{a_1}(p) + P_{a_2}(p)$$

$$\therefore P_a(p) = e^{-\lambda_1 \lambda_2} \left[\frac{\lambda_1^3}{3!} \left(1 + \lambda_2 + \frac{\lambda_2^2}{2!} + \frac{\lambda_3^3}{3!}\right) + \frac{\lambda^4}{4!}\left(1 + \lambda_2 + \frac{\lambda_2^2}{2}\right) + \frac{\lambda_1^5}{5!}(1 + \lambda_2) + \frac{\lambda_1^6}{6!} \right]_6$$

$$ASN = n_1 + n_2(1 - P_1) = n_1 + n_2 \sum_{q=3}^{6} e^{-\lambda_1} \frac{\lambda_1^q}{q!}$$

$$ATI = n_1 + n_2(1 - P_{a_1}) + (N - n_1 - n_2)(1 - P_a)$$

$$AOQ = \left(\frac{N - n_1}{N}\right) p \cdot P_{a_1}(p) + \left(\frac{N - n_1 - n_2}{N}\right) p \, P_{a_2}(p)$$

where. N = size of lot

n_1 = size of the first sample

n_2 = size of the second sample

p = Incoming quality of lot

$P_{a_1}(p)$ = Probability of accepting the lot on basis of 1ST sample.

$P_{a_2}(p)$ = Probability of accepting the lot on basis of second sample

x = no. of defects in first sample

y = no. of defects in second sample

p	$\lambda_1 = n_1 p$	$Pa_1(p)$	λ_2	$Pa_2(p)$	ASN $Pa(p)$	ATI	AOQ
0.01	0.5	0.985612322	1	0.013969816	51.438667	51.5850099	0.008968299
0.02	1.0	0.919698602 9	2	0.064239147	58.021801559	63.651792765	0.017453922
0.03	1.5	0.808846830 5	3	0.104140332	69.022717	99.569810 3	0.024025811
0.04	2.0	0.676676462	4	0.103226252	81.878977	159.3664251	0.027250686
0.05	2.5	0.543813115 9	5	0.07619463	94.1999568	228.5159785	0.027138402
0.06	3.0	0.423190081 1	6	0.046162979	104.33938	293.4074223	0.024711.09
0.07	3.5	0.320647989	7	0.024273942	111.306469	347.122883	0.021402996
0.08	4.0	0.238033056	8	0.011473565	115.1222684	388.8377629	0.017735157
0.09	4.5	0.173578 0709	9	0.004990834129	115.747246	420.1430802	0.014374245
0.1	5.0	0.124652 0195	10	0.002031117057	113.753143	443.1957005	0.011860859
0.15	7.5	0.020256715 06	15	0.000116636245	85.789779	490.8803962	0.002735831
0.2	10	0.002769395 7	20	0.000000003462	62.7372052	498.75375	0.000433 49
0.25	12.5	0.000341454 5969	25	0.000000000 7109	53.4225439	499.8463454	0.000 76 8272
0.3	15	0.000037308 448	30	0.000000000 1193	50.75125912	499.9823112	0.000010613

Calculations:
$N = 500$, $n_1 = 50$, $n_2 = 100$, $C_1 = 2$ and $C_2 = 6$

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25/4/23 **Practical No.-16**

Aim- To plot the OC, ATI and AOQ curve

Problem - Plot OC, ATI and AOQ curve given that $p = 0.01, 0.02, 0.03, 0.04, 0.06, 0.08, 0.1, 0.2, 0.3, 0.4, 0.5, 0.8$ for $C = 3$, $n = 30$ and $N = 1000$

Theory - OC function the probability of acceptance for the different values of incoming quality level p

(i) $P_{acc} = L(p) = \sum_{x=0}^{c} g(x, n, p)$

as $L(p)$ is finite and $N \to \infty$ and p is small

$\therefore L(p) = \sum_{x=0}^{c} e^{-np} \frac{(np)^x}{x!}$

(ii) $ATI = N + (n - N) P_{acc}$

(iii) $AOQ = p \cdot P_{acc} \frac{(N-n)}{N} = \hat{p}$

Calculations-

$C = 3, n = 30, N = 1000, L(p) = e^{-np}\left[1 + np + \frac{(np)^2}{2!} + \frac{(np)^3}{3!}\right]$

p	np	$L(p)$	ATI	AOQ
0.01	0.3	0.9997341838	30.25783685	$9.69742163 \times 10^{-3}$
0.02	0.6	0.9966419311	33.25732679	0.019334853 46
0.03	0.9	0.9865 412794	43.0549 5902	0.02870 8351 23
0.04	1.2	0.9662310318	62.7553 9914	0.037489 76403
0.06	1.8	0.8912916053	135.4471429	0.051 8 7317143
0.08	2.4	0.77872911	244.6387763	0.06042 88971
0.1	3	0.6472 318 888	372.1850679	0.06278149321
0.2	6	0.1512038820	858.3322337	0.02933355326
0.3	9	0.0212264863	979.4103083	0.0006 176907514
0.4	12	0.0022917912	997.7769625	0.00088 92149886
0.5	15	0.0002113785	999.7849629	0.0001025135742
0.8	24	0.000000098795 27	999.9999042	$7.66513031 \times 10^{-8}$

27/4/23

Practical No-17

Aim - To plot the OC curve for given data

Experiment - Using hypergeometric dist. plot OC curve for the single sampling plan with $N = 2000$, $n = 20$, $c = 0$ and $p = 0.01$, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.09, 0.1, 0.3, 0.4, 0.6, 0.8, 0.9

Theory - OC function is the prob of acceptance for different values of the incoming quality level p.

$$L(p) = \sum_{x=0}^{c} g(x, n, p)$$ where np is finite, $N \to \infty$ and p is small

$$L(p) = P_{acc} = \sum_{x=0}^{c} f(x, n, p)$$

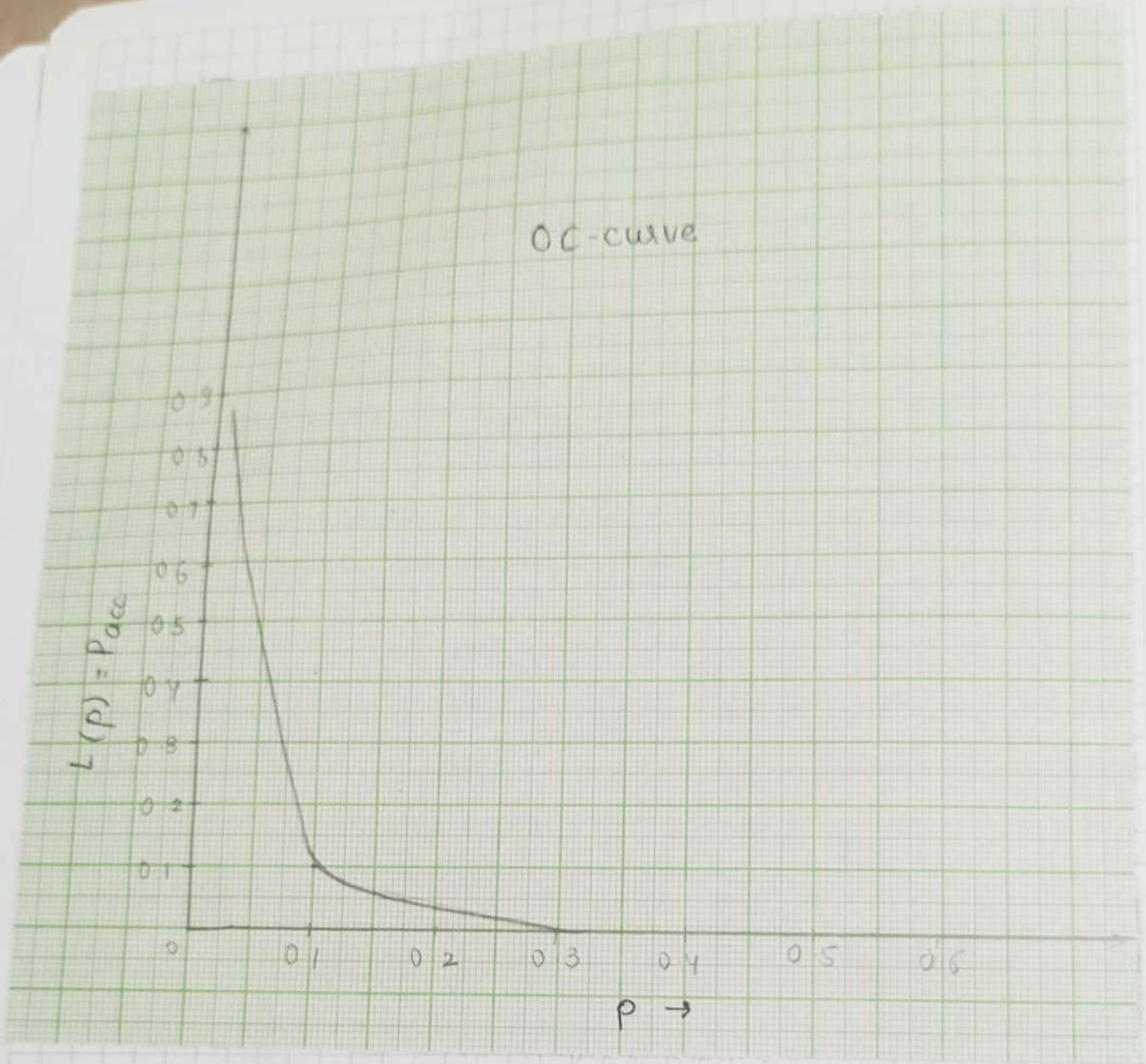
$$= \sum_{x=0}^{c} {}^{Np}C_x \, \frac{{}^{N-Np}C_x}{{}^{N}C_n}$$

Calculation -

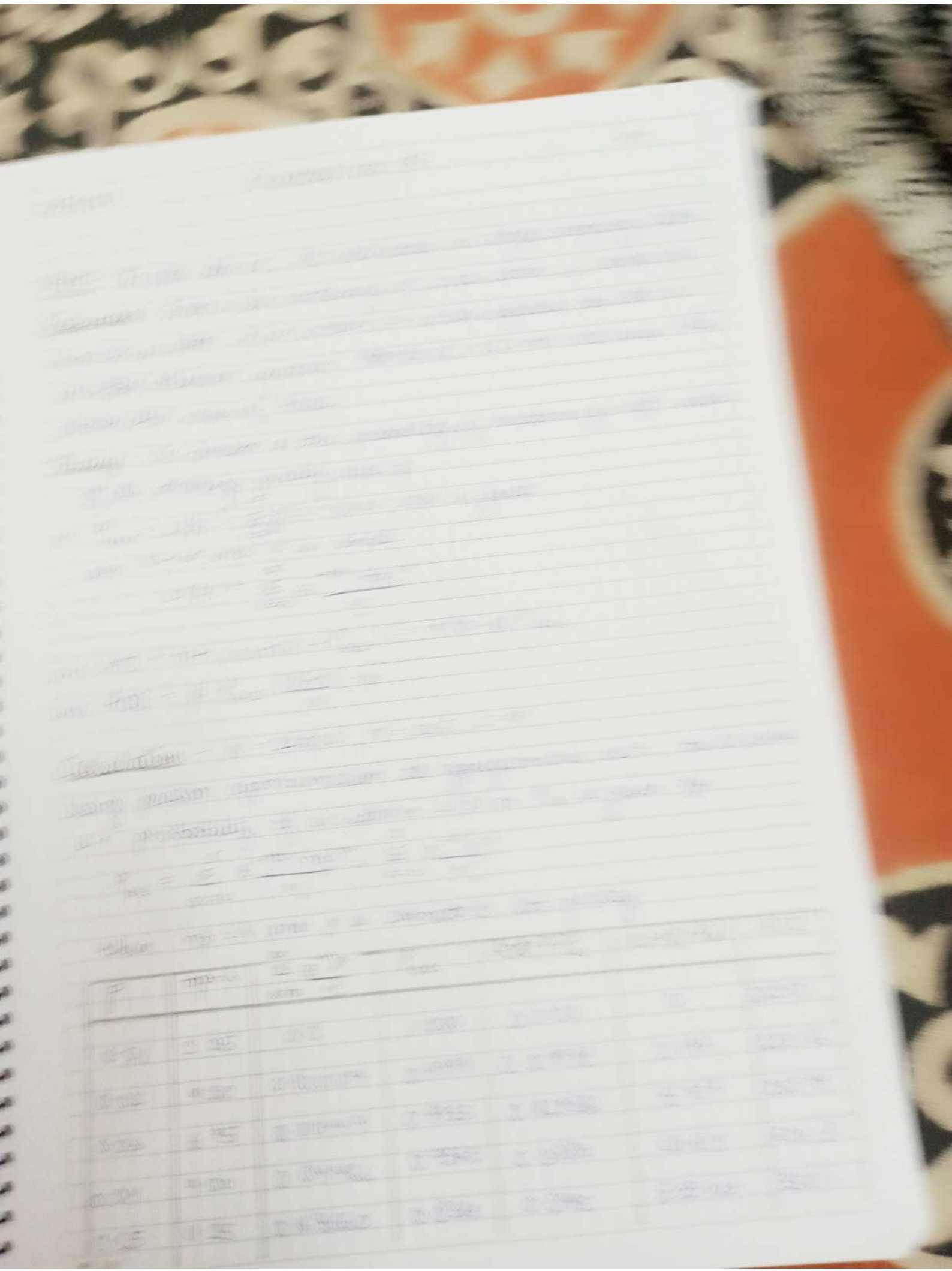
$$L(p) = P_{acc} = \frac{{}^{Np}C_0 \; {}^{N-Np}C_n}{{}^{N}C_n} = \frac{{}^{2000}C_0 \; {}^{2000p}C_{20}}{{}^{2000}C_{20}}$$

p	P_{acc}
0.01	0.81711
0.02	0.666306
0.03	0.5427
0.04	0.4402
0.05	0.3566
0.06	0.288
0.07	0.232
0.08	0.1871
0.09	0.15021
0.1	0.1202
0.3	7.658
0.4	3.42987
0.6	9.5197
0.8	7.1649
0.9	4.1182

Since, $c = 0$, $L(p) = \frac{2000 - 2000p \, C_{20}}{2000 \, C_{20}}$



Result - The OC curve is plotted above in the graph



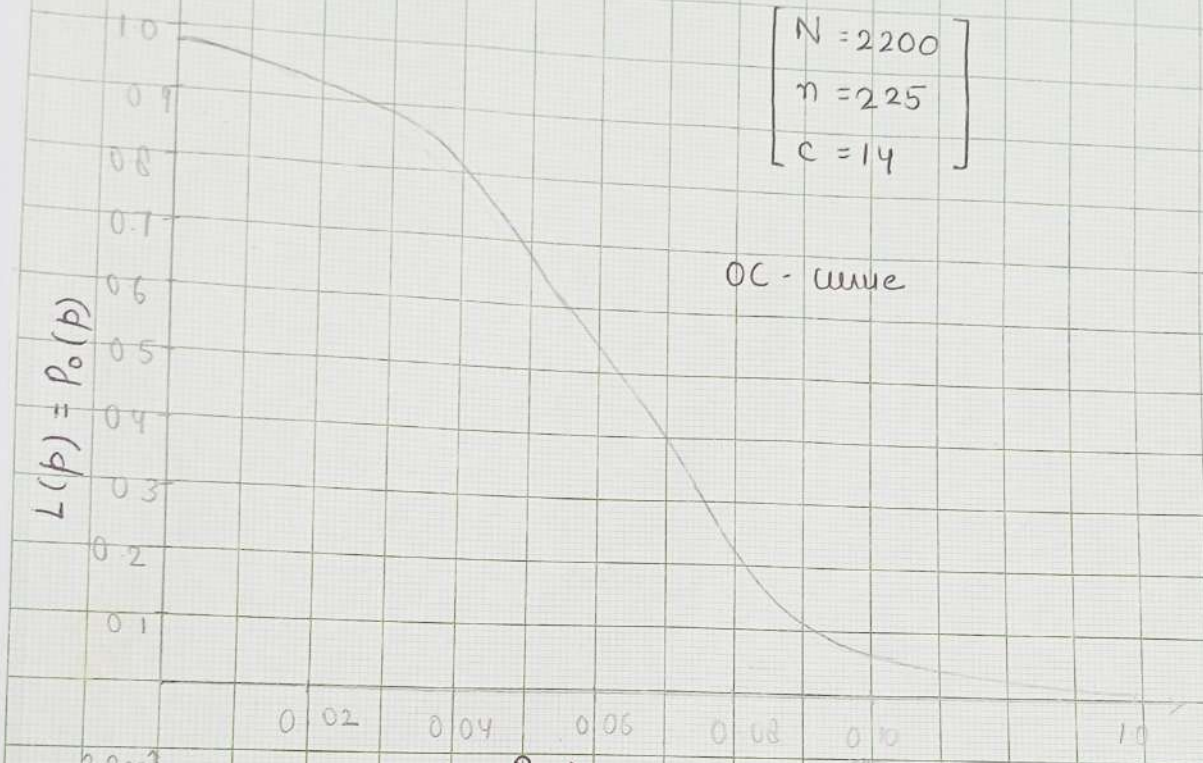
0·06	13 50	0 376729	0 62327	0 3739	744·039	969·0
0 08	18 00	0·791623	0 2080	0 16646	1569·04	17090
0·10	2250	0 968926	0·031074	0 03107	1913·62	213962
0·30	6750	1·00	0	0	1975·00	2200·0
0·80	180·00	1·00	0	0	1975·00	2200·0

(16)

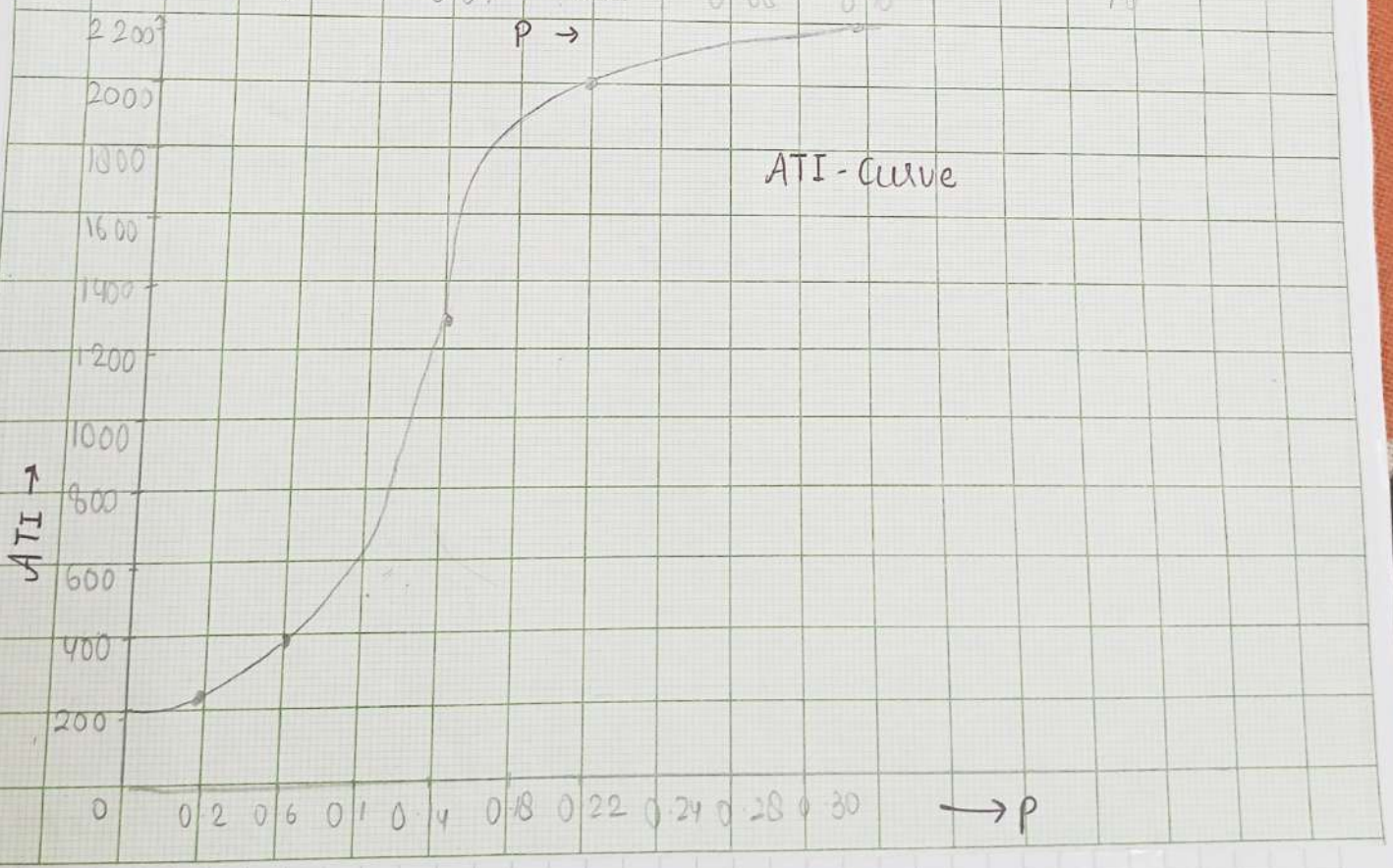
(18)

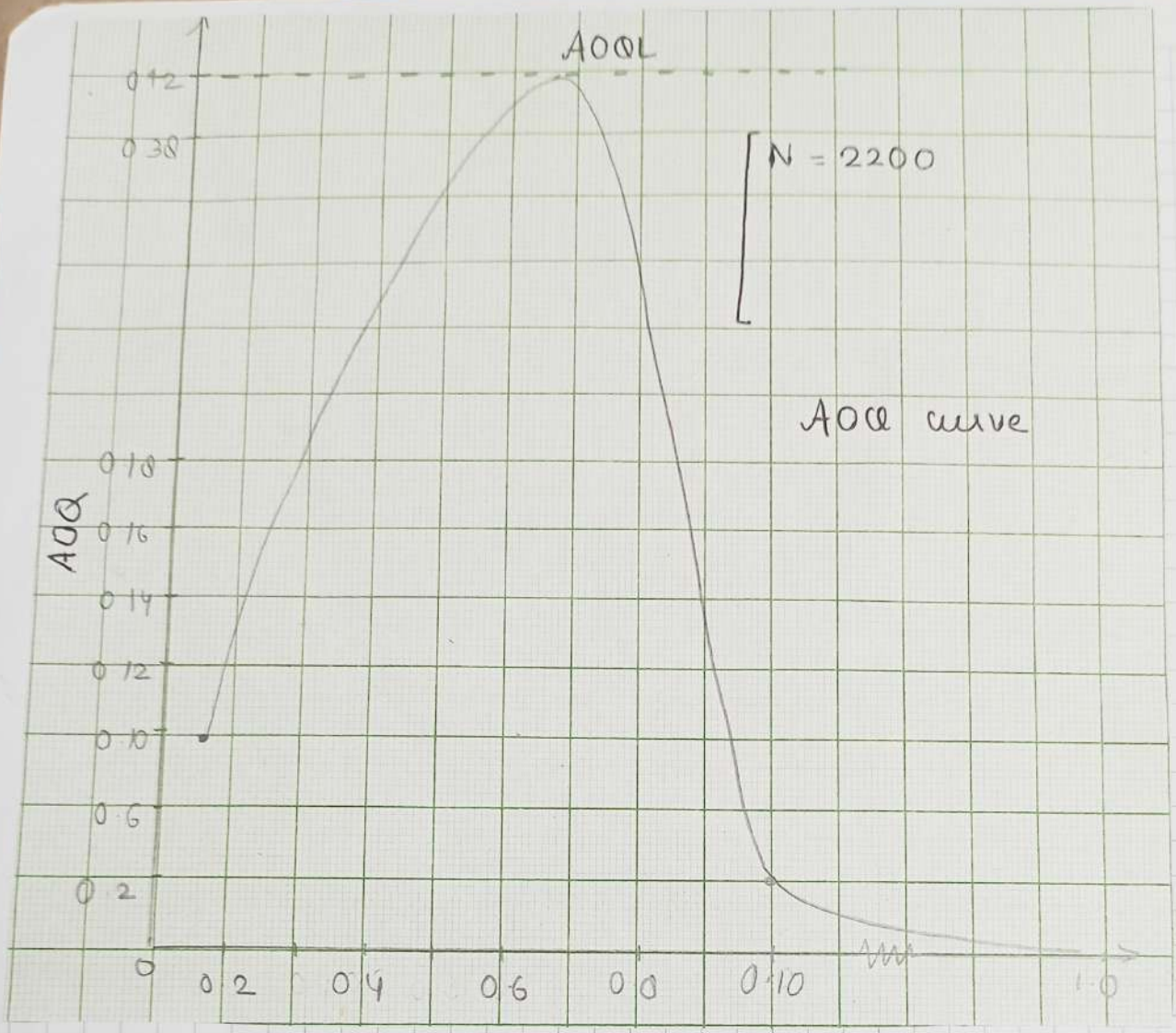
$$\begin{bmatrix} N = 2200 \\ n = 225 \\ c = 14 \end{bmatrix}$$

OC - curve



ATI - Curve





Result - The OC, ATI and AOQ curves are plotted above in the graph and AOQL = 0.837