	Data science	Web Dev	Total
Male	30	20	50
Female	25	45	70
Total	55	65	120

Test whether course preference depends on gender.

⇒ Null Hypothesis = Ho = course is not depends on gender.

Alternate Hypothesis = H_1 = couse is depends on gender.

* calculate Eaepected value :

$$= \frac{\text{Total row value} \times \text{Total column value}}{\text{Grand value.}}$$

Male = Data science: $\frac{50 \times 55}{120} = 22.91$; web Dev: $\frac{50 \times 65}{120} = 27.08$

Female = Data science: $\frac{70 \times 55}{120} = 32.08$; web Dev: $\frac{70 \times 65}{120} = 37.91$

	O	E	$(O-E)^2$	$(O-E)^2/E$
Male - Data S.	30	22.91	50	~~1.005~~ 2.2
Male - web D.	20	27.08	50.12	1.85
Female - Data S.	25	32.08	50.12	2.005
Female - web d.	45	37.91	50.26	1.32

$$\chi^2 = 2.2 + 1.85 + 2.005 + 1.32 = \underline{\underline{7.375}}$$

degree of freedom = (row-1) (column-1)
= (2-1) (2-1) = 1

$\alpha = 0.05$

χ^2 critical = ~~7.879~~ 3.841

$\chi^2 > \chi^2$ critical:

We need to reject Null Hypothesis
It is mean course preference depends on

Q.2] Advertisement Type Vs purchase ($\alpha = 0.05$)

Advertisement	purchased	Not P.	Total
TV	40	30	70
Social Media	35	25	60
Newspaper	20	30	50
Total	95	85	180

Test whether purchase decision is independent of advertisement type.

⇒ Null Hypothesis = H_0 = Independent

Alternate Hypothesis: H_1 = dependent.

* calculate Expected value:

$$= \frac{\text{Total row} \times \text{Total column}}{\text{Grand value}}$$

	purchased	Not purchased
T.V.	$\frac{70 \times 95}{180} = 36.94$	$\frac{70 \times 85}{180} = 33.05$
S. Media	$\frac{60 \times 95}{180} = 31.66$	$\frac{60 \times 85}{180} = 28.33$
News paper	$\frac{50 \times 95}{180} = 26$	$\frac{50 \times 85}{180} = 23.61$

	O	E	$(O-E)^2/E$
T.V - Purchased	40	36.94	0.253
T.V - Not p.	30	33.05	0.281
S.M - purchased	35	31.66	0.352
S.M - Not p.	25	28.33	0.391
N.P - purchased	20	26	1.384
N.P = Not -p	30	23.61	1.729

$$x^2 = 0.253 + 0.281 + 0.352 + 0.391 + 1.384 + 1.729$$

$$\boxed{x^2 = 4.39}$$

$$df : (row-1)(column-1) : (3-1)(21) = 2$$

$$\alpha : 0.05$$

$$x^2_{critical} = 5.991$$

$x^2 < x^2_{critical}$: We failed to reject Nwul Hypothesis

It means purchase decision is indeependent on advertisement Type.

Q.9 Blood Group Distribution ($\alpha = 0.05$)

Blood Group	observed	Expected (%)
A	90	40%
B	50	30%
AB	20	10%
O	40	20%
	200	100%

Test Goodness of Fit.

⇒ Null Hypothesis : H_0 : Blood group distribution follows the expected %.

Alternet Hypothesis: H_1 : Not follows expected %.

	A	B	AB	O
Expected values	0.4×200	0.3×200	0.1×200	0.2×200
	$= 80$	$= 60$	$= 20$	$= 40$

Blood Group	O	E	$(O-E)^2/E$
A	90	80	1.25
B	50	60	1.66
AB	20	20	0
O	40	40	0
			$\chi^2 = 2.91$

$df = 4-1 = 3$ $\quad\quad$ $\chi^2_{critical} = 7.815$

$\alpha = 0.05$

$\chi^2 < \chi^2_{critical}$: we failed to Reject Null Hypothesis.

It's means, The Bloodgroup distribution follows the expected values of 1.

Q.4] Smoking Vs lung Disease ($\alpha = 0.05$)

	Disease	No Disease	Total
Smokers	35	40	75
Non-smokers	15	60	75
Total	50	100	150

Test wheater smoking is associated with lung disease.

→ Null Hypothesis = H_0 = Smoking is not associated with lung disease.

Alternate Hypothesis = H_1 = Smoking is associated with lung disease.

	Disease	No Disease
Smokers	$= \frac{75 \times 50}{150} : 25$	$= \frac{75 \times 100}{150} = 50$
Non smokers	$= \frac{75 \times 50}{150}$ $= 25$	$= \frac{75 \times 100}{150}$ $: 50$

	O	E	$(O-E)^2/E$
Smokers - Disease	35	25	4
Smokers : No Disease	40	50	2
Non smoker : Disease	15	25	4
Non smoker : No Disease	60	50	2

$\chi^2 = 12$:

$df = (2-1)(2-1) = 1$

$\alpha = 0.05$

$\chi^2_c \alpha = 3.841$

Conclusion: $\chi^2 > \chi^2_{critical}$ =

We reject Null Hypothesis.

It's means smoking is dangrous for lungs.
It causes lungs disease.

Q.5] Dice Fairness (Goodness to Fit, $\alpha = 0.05$)

Face	1	2	3	4	5	6
Frequency	18	22	16	20	25	19

A dice was rolled 120 times. Test whether the dice is fair.

→ Null Hypothesis: H_0 = Dice is fair

Alternate Hypothesis: H_1 = Dice is not fair.

i) If dice is rolled for 1 time Probability: $\frac{1}{6}$

Now dice is rolled 120 Times $= \frac{120}{6} = 20$

∴ Expect value for all the face is = 20

Face	O	E	$(O-E)^2/E$
1	18	20	0.2
2	22	20	0.2
3	16	20	0.8
4	20	20	0
5	25	20	1.2
6	19	20	0.05

$\chi^2 = 0.2 + 0.2 + 0.8 + 0 + 1.2 + 0.05$

$\boxed{\chi^2 = 2.45}$