1. Kruskal Wallis's H-Test.

Three machines are used in the Packaging of 10kgs of wheat flour. Each machine is designed so as to pack on an average 10kg of flour per bag. Samples of 6 bags were selected from each machine and the amount of wheat flour packaged in each bags is shown below.

Machine 1: 15.8 15.9 16.2 15.7 16.3 15.

Machine 2: 16.5 16.0 15.4 15.9 16.2 16.

Machine 3: 15.7 16.4 16.2 15.9 15.7 16.

Use a 5% level of significance to test the hypothesis that amount of wheat Packaged by the 3 machines are same

Sol:

H_0: Wheat flour packed by these machines are same.

Sample observations	M_1	M_2	M_3
15·4		1	
15·7	3		
15·7			3
15·7			3
15·8	5·5		
15·8	5·5		
15·9	8		
15·9		8	
15·9			8
16·0		10	
16·1		11	
16·2			13
16·2	13		
16·2		13	
16·3	15·5		
16·3			15·5
16·4			17
16·5		18	
	50·5	61	59·5

$$H = \frac{12}{N(N+1)}\left\{\frac{R_1^2}{n_1} + \frac{R_2^2}{n_2} + \frac{R_3^2}{n_3}\right\} - 3(N+1)$$

$$= \frac{12}{18(18+1)}\left\{\frac{(50.5)^2}{6} + \frac{(61)^2}{6} + \frac{(59.5)^2}{6}\right\} - 3(18+1)$$

$$\frac{12}{18(19)}\left\{\frac{2550.25}{6} + \frac{3721}{6} + \frac{3540.25}{6}\right\}$$

$$\frac{12}{340}\left\{425.0417 + 680.1667 + 590.0417\right\} - 57$$

$$= 0.0351\left\{1635.2501\right\} - 57$$

$$= 0.3973$$

Table value of χ^2 distribution with 2 degrees of freedom [$\{k-1\}, k$ is the no. of samples i.e $3-1=2$].

$5.991 \rightarrow$ T.V.

$\therefore$ Since our calculated less than table value. We accept our H_0.

2. The same mathematics papers whose marked by 3 teachers A, B and C the final marks were recorded as follows

Teacher A :→ 73 89 82 43 80 73 66 45 93 36 77

Teacher B :→ 88 78 48 91 57 85 74

Teacher C :→ 31 78 62 76 68 79 56 91 71 71 87 41 59 68 53 79

Use Kruskall Wallis's test at 5% l.o.s to determine if the marks distribution given by the three teachers differ Significantly.

Sln:

	A	B	C
31		1	
Teach			
36	2		
41			3
43	4		
45	5		
48		6	
51		7	
53			8
56			9
59			10
60	11		
62		12	
66	13		
68			14.5
68			14.5
71			16.5
71			16.5
73	18.5		
73	18.5		
74		20	
76		21	
77	22.5		
77		22.5	
78		24.5	
78		24.5	
79			26.5

A Survey is Conducted to test the difference between two alternative methods of teaching. A Sample of 20 Students is Selected at random Two groups of 10 students each of equal ability are formed, and thought by different methods. A Standarised test is then given to both the groups and the following marks (out of 100) are Scored by the 10 students in each group.

Group A: 40 45 48 46 52 58 62 85
67 73

Group B: 42 68 45 64 86 78 87 68 84
90

Using U-test at 5% l.o.s, to test the significance of difference between the Performance of two groups.

3. A large Corporate hospital hires most of its doctors from two major Universities Over the last year hospital has been Conducting test for the newly recruited doctors to determine which University educates better. Based on the following scores, help the human resource department of the hospital to decide whether the Universities differ in quality. Use Man whitney U test and you may assume 5% l.o.s

Uni A: 99 83 89 64 98 85 61 79 91 87
88

Uni B: 96 90 97 94 86 95 68 78 93 56
76 84

2.

X	R_x	Y	R_y
40	1	42	2
45	3.5	45	3.5
46	5	62	9
48	6	64	10
52	7	68	12
58	8	78	15
67	11	84	16
72	13	85	17.5
73	14	87	19
85	17.5	90	20
	86		124

$R_1 = \Sigma R_x$

$R_1 = 86$

$R_2 = \Sigma R_y = 124$

$U_1 = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$

$= (10)(10) + 10\frac{(10+1)}{8} - 86$

$= 100 + 55 - 86$

$= 69$

$U_{12} = 89$

$U_{21} = n_1 n_2 - U_{12}$

$= (10)(10) - 89$

$= 100 - 89$

$= 11$

$U = \text{Min}(U_{12}, U_{21})$

$= \text{Min}(89, 11)$

$U = 11$

No. of times repeated

2, 2.

$(t_1 = 2, t_2 = 2)$

$T_1 = \frac{t_1^3 - t_1}{12} = \frac{(2)^3 - 2}{12} = \frac{6}{12} = 3/6 = 1/2$

$T_2 = \frac{t_2^3 - t_2}{12} = \frac{(2)^3 - 2}{12} = 1/2.$

$\Sigma T_i = T_1 + T_2$

$= 1/2 + 1/2 = 0.5 + 0.5 = 1$

$Z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (N+1)}{12} - \frac{n_1 n_2}{N(N-1)} \Sigma T_i}}$

$$\frac{31 - \frac{(10)(10)}{2}}{\sqrt{\frac{(10)(10)(21)}{12} - \frac{(10)(10)}{20(1091)}}} \quad (1)$$

$$= \frac{31 - 50}{\sqrt{\frac{2100}{12} - \frac{100}{380}}} \quad (1)$$

$$= \frac{-19}{\sqrt{\frac{91.6667 - 0.2632}{175}}}$$

$$= \frac{-19}{\sqrt{\frac{91.4035}{174.7368}}} = \frac{-19}{\frac{9.5605}{13.2188}}$$

$$= 1.4374$$

$T \cdot V = 1.96$

Since Our Calculated Value is less than table Value. We accept Our H_0

X	R_x	Y	R_y
61	2		
64	3	56	1
79	4	68	4
81	7	76	5
83	8	78	6
85	10	84	9
87	12	86	11
88	13	90	15
89	14	93	17
91	16	94	18
98	22	95	19
99	23	96	20
		97	21
	130		146

$R_1 = \Sigma R_x$

$R_1 = 130$

$R_2 = \Sigma R_y = 124$

$$U_{12} = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

$$= (11)(12) + \frac{11(11+1)}{2} - 130$$

$$= 132 + 66 - 130$$

$$= 68$$

$$U_{21} = n_1 n_2 - U_{12}$$

$$= (11)(12) - 68$$

$$= 64$$

$U = \text{Min}(U_{12}, U_{21})$

$= \text{Min}(68, 64)$

$= 64$

$\Sigma T_i = 0$

$$Z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (N+1)}{12} - \frac{n_1 n_2}{N(N-1)} \Sigma T_i^3}}$$

$$= \frac{64 - \frac{(11)(12)}{2}}{\sqrt{\frac{(11)(12)(24)}{12} - \frac{(11)(12)}{23(23-1)} (0)}}$$

$$= \frac{64 - 66}{\sqrt{264 - 0.2609}}$$

$$= \frac{64 - 66}{\sqrt{263.7391}} = \frac{2}{16.2400}$$

$= 0.1232$

T.V = 1.96

Since Our Calculated Value is less than table Value. We accept Our H_0.

2. For 9 animals tested Under Control Conditions and experimental Conditions the following Values of a measured Variable where observed

Animal no:	1	2	3	4	5	6	7	8
Control :	21	24	26	32	55	82	46	52
experimental:	18	9	23	86	82	199	42	80

Test at 5%. 1.0.5 whether Significant difference exits between the Medians Using Wilcoxon Signed Rank test.

Ans :- 220.5 235 210.5

$$H = \frac{12}{N(N+1)} \left\{ \frac{R_1^2}{n_1} + \frac{R_2^2}{n_2} + \frac{R_3^2}{n_3} \right\} - 3(N+1)$$

$$= \frac{12}{36(36+1)} \left\{ \frac{(220.5)^2}{12} + \frac{(235)^2}{10} + \frac{(210.5)^2}{10} \right\} - 3(36+1)$$

$$= \frac{12}{36(37)} \left\{ \frac{48620.25}{12} + \frac{55225}{10} + \frac{44310.25}{10} \right\} - 3(37)$$

$$= \frac{12}{1332} \{ 4051.6875 + 4602.08333 + 3692.5208 \} - 111$$

$$= 0.0090 \{ 12346.2916 \} - 111$$

$$= 0.1166.$$

Table Value = ~~0.1166~~ 5.991

Since Our Calculated Value is less than table Value. So we accepting Our H_0.

2) Sol:

Animal no	Control equip		C-E	|C-E|	R
1	21	18	3	3	1.5
2	24	9	15	15	5
3	26	23	3	3	1.5
4	32	26	6	6	4
5	55	82	-27	27	8
6	82	199	-117	117	9
7	46	42	4	4	3
8	55	30	25	25	6
9	88	62	26	26	7

Sum of the rank of positive values $\Rightarrow 1.5+5+1.5+4+3+6+7+8+9 = 45$

Sum of the rank of negative values $\Rightarrow 8+9 = 17$

$T = \text{Min}(T_+, T) = \text{Min}(28, 17) = 17$

$\mu_T = \frac{n(n+1)}{4} = \frac{9(9+1)}{4} = \frac{9(10)}{4} = 22.5$

$\sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{24}}$

$$= \sqrt{\frac{9(9+1)(2(9)+1)}{24}}$$

$$= \sqrt{\frac{9(10)(18+1)}{24}} = \sqrt{\frac{(90)(19)}{24}} = \sqrt{\frac{1710}{24}}$$

$$= 8.4401 \sqrt{71.25} = 8.4401$$

$$Z = \frac{T - \mu_T}{\sigma_T} = \frac{17 - 22.5}{8.4401} = \frac{-5.5}{8.4401}$$

$$= -0.6517$$

$$|Z| = 0.6517$$

Table Value 1.96

Since our Calculated Value less than table Value. So we accepting our H_0

Kolmogorov Smirnov test (K.S. Test)

A manufacturer of readymade garment Conducts a market Survey to know the choice of brands A, B, C and D of 100 prospective Customers. The results are A = 20, B = 30, C = 18, D = 32. O.F

Use Ks test at 5% l.o.s to know