Problem I (44 points) Several species of fungi are significant pathogens for humans and other animals. Fungi also cause major losses due to diseases of crops or food spoilage. A microbiologist designed a study involving several factors to determine which factor combinations may have the greatest impact on the growth of a particular fungus. The factors selected for study are three Growth Times: 25, 50, 75 hours; three Humidity Levels: 45%, 60%, 85%; and two Growth Media, M_1, M_2. Two samples of the fungus were randomly assigned to each of the 18 treatments and the growth in the fungus was recorded, The data is given in the following table.

		Growth Media-M_1			Growth Media-M_2		
	Humidity	45%	60%	85%	45%	60%	85%
Time(Hrs)	25	8.1, 8.9	2.2, 1.1	18.6, 12.3	10.2, 11.8	15.7, 10.3	21.1, 21.9
	50	8.8, 9.3	4.5, 8.4	11.3, 8.7	12.7, 13.3	17.5, 16.4	26.2, 22.4
	75	8.8, 7.7	6.0, 1.7	10.2, 12.6	15.2, 19.4	22.1, 20.3	33.1, 30.2

Use the SAS output to answer the following questions.

1. (16 points) Do the necessary conditions for testing hypotheses and constructing confidence intervals appear to be satisfied? **Justify your answers.** Use $\alpha = 0.05$ if needed.

C_1- Normality:

symmetric

Yes, looking at the histogram (of the residuals), the qqplot of the residuals and the SW-test for normality of the residuals we see that the normality condition is satisfied.

state the p-value

C_2- Equal Variance:

B/C we have less than 3 reps per treatment, the BFL test is not applicable. looking at the plot of the residuals vs means we have a visual indication that equal variance seems to be satisfied, though, looking at the box plots for each of the treatments seems to indicate otherwise. Need to investigate further.

2. (10 points) Group the three Humidity Levels such that all Humidity Levels within a group do not have significantly different mean fungi growth. Use $\alpha_F = .05$ and **justify your answers.**

Note: The three way interaction is not significant, however 2 of our 3 2-way interactions are significant, so we must group Humidity for Growth times (T) & Growth Media (M) separately.

• use $\alpha_{PC} = \frac{0.05}{(6+9)} = 0.00\overline{33}$ ✗

M_1 45, 60, 85

$M = M_1$: $G_1 = \{45\%, 85\%\}$, $G_2 = \{60\%\}$

M_2 45, 60, 85

$M = M_2$: $G_1 = \{45\%, 60\%\}$ $G_2 = \{85\%\}$

see the answer key

-4

* see practice exam, and diagram included on cheatsheet

25 45, 60, 85

$T = 25$: $G_1 = \{45\%, 60\%\}$, $G_2 = \{85\%\}$

$T = 50$: $G_1 = \{45\%, 60\%\}$, $G_2 = \{85\%\}$

50 " "

$T = 75$: $G_1 = \{45\%, 60\%\}$, $G_2 = \{85\%\}$

75 " "

3. **(10 points)** **Is the mean growth of the fungi different for the two growth media? Use $\alpha_F = .05$ and justify your answer.**

Three way interaction not significant : 2 of the two way interactions are significant. ⇒ we cant just look at $\mu_{1\cdot\cdot} - \mu_{2\cdot\cdot}$ We must do a tukey comparison of the means of the media separately over the levels of humidity averaged over temp and also do a tukey comparison of the means of media, separately over the levels of temp, averaged over humidity.

using $\alpha_{pc} = \frac{0.05}{6+6} = 0.0041667$

Temps:

M=1: $G_1 = \{25, 50, 75\}$

M=2: $G_1 = \{25, 50\}$, $G_2 = \{75\}$

See the answer key -9

Humidities:

M=1: $G_1 = \{45\%, 85\%\}$, $G_2 = \{60\%\}$

M=2: $G_1 = \{45\%, 60\%\}$, $G_2 = \{85\%\}$

yes, the mean growth of the fungi is different for the two growth media at the $\alpha_F = 0.05$ level. We see this, b/c for both Temps & Humidities, the groupings of the treatment means are different for the levels of media.

4. **(8 points)** Provide a 95% confidence interval for the mean growth of fungus over a 50 hour period in Growth Media M_1 with a humidity of 60%. **Justify your answer.**

95% CI on $\mu_{1,50,60\%}$

$t^* = t_{0.975, 18} = 2.101$

$\hat{\mu}_{1,50,60} = 6.4500$

$SE(\hat{\mu}_{1,60,50}) = 1.5224250$

$\boxed{95\%\ CI:\ 6.45 \pm 2.101(1.5244250) = (3.24718\,3075,\ 9.652816925)}$

Problem II. (**56 points**) CIRCLE (A, B, C, D, or E) corresponding to the BEST answer. Only ONE LETTER should be CIRCLED for each of the 14 questions.

(1.) There are hundreds of laboratories that are federally qualified to produce assessments of the level of e. coli in meat. Research group will be randomly selecting 10 laboratories from the list of all laboratories to determine if there is a difference in the accuracy of the determinations across the many laboratories or are the laboratories all essentially the same in the quality of the determinations. Which of the following is a correct statement?

✓

- (a) labs are blocks
- (b) labs have fixed effects
- (c) labs have random effects
- (d) all labs should be used for us to make inference
- (e) we should request another list of labs to answer the research question

✓

(2.) REML uses the joint pdf of the data in obtaining estimates of the variance components whereas the AOV-MOM estimates only make use of the first two moments of the distribution of the data (variance) in obtaining estimates. Which method is preferred making inferences on variance components in a mixed model?

- (a) REML because it produces positive variance(s) each time
- (b) AOV-MOM because both more accurate and precise than the REML
- (c) REML because it produces negative variance(s) each time
- (d) AOV-MOM because it produces positive variance(s) each time
- (e) AOV-MOM because it produce(s) negative variance each time

$\bar{x} = \frac{T}{2} \Rightarrow var(\bar{x}) = var(T/2)$

$= \frac{1}{4} var(T) = \frac{1}{4}(\sigma_c^2 + a)$

$SE(\bar{x}) = \sqrt{\frac{1}{4}(\sigma_c^2 + a)}$

$= \frac{1}{2}\sigma_c + \frac{1}{2}\cdot\sqrt{a}$

(3.) A CRD experiment is conducted with five treatments. The researcher conducts both an F-test for testing for treatment differences and a Kruskal-Wallis' rank based test. The F-test yields a p-value of .027 whereas the Kruskal-Wallis' test yields a p-value of .235. What is the most probable reason for the difference in the conclusions reached by these two tests?

- (a) violation of normality or existing outliers
- (b) violation of normality or equal variance or existing outliers
- (c) violation of equal variance or existing outliers
- (d) violation of normality and equal variance and existing outliers
- (e) they will always be different without any specific reason

let $T = x_1 + x_2$

$var(T) = var(x_1) + var(x_2) + 2cov(x_1, x_2)$

ρ: $var(x_1) = var(x_2) = \sigma_c^2$

& $cov(x_1, x_2) = a > 0$; let

$var(T) = 2(\sigma_c^2 + a)$

(see H.O. 5 pg. 50)

* didn't get marked off for.

$\cancel{-4}$

(4.) Which of the following is the impact of $\boxed{\text{positively}}$ correlated data on inference procedures?

- (a) narrower confidence interval for the mean and the coverage probability is greater than $100(1 - \alpha)\%$.
- (b) narrower confidence interval and the coverage probability is less than $100(1 - \alpha)\%$.
- (c) wider confidence interval for the mean and the coverage probability is less than $100(1 - \alpha)\%$.
- (d) wider confidence interval for the mean and the coverage probability is greater than $100(1 - \alpha)\%$.
- (e) no impact on the confidence interval for the mean

(5.) Over-dispersion is a phenomenon that sometimes occurs in data that are modelled with the binomial or Poisson distributions. We look at the estimate of dispersion after fitting (measured by the deviance or Pearson's chi-square divided by the degrees of freedom) to determine overdispersion. Which of the following case indicate an overdispersion in Poisson distribution?

✓

- (a) If the estimate is 0.99 and the mean is greater than variance
- (b) If the estimate is 2.3 and the mean is greater than variance
- (c) If the estimate is 0.99 and the mean is equal to variance
- (d) If the estimate is 2.3 and the mean is less than variance
- (e) If the estimate is 1 and the mean is greater than variance

(6.) Suppose factor F_1 has two levels and factor F_2 has three levels in full factorial design with no significant interaction. Which if the following is not one of the main effect contrasts for F_2?

(a) $2\mu_{.1} - \mu_{.2} - \mu_{.3}$
(b) $-\mu_{.1} + 2\mu_{.2} - \mu_{.3}$
(c) $-\mu_{.1} - \mu_{.2} + 2\mu_{.3}$
(d) $\mu_{.1} - \mu_{2}.$
(e) all of the above are not one of the main effect contrasts for F_2

(7.) A researcher is studying the absorption times of two types of antibiotic capsules: T_1, T_2 having wall thicknesses of .2, .4, .6, .8 mm. The researcher randomly assigns a wall thickness and type of capsule, to the capsule formulation (FORM) machine, and produces a capsule. The researcher then determines the absorption time for the capsule. There are 10 replications of each Type-Thickness combination. We are interested in contrasts in the 8 treatment means $\mu_{ij}, i = 1, 2, j = 1, 2, 3, 4$ to evaluate a linear trend in the mean absorption time across the levels of wall thickness for each of following two situations:

(i) The interaction between Type and Thickness is significant. Which of the following contrasts evaluate a linear trend in the mean absorption time across the levels of wall thickness when type=T1?

~~(a)~~ $-3\mu_{21} - \mu_{22} + \mu_{23} + 3\mu_{24}$
~~(b)~~ $-3\mu_{21} - \mu_{22} + \mu_{23} + 3\mu_{24} - 3\mu_{11} - \mu_{12} + \mu_{13} + 3\mu_{14}$
(c) $-3\mu_{11} - \mu_{12} + \mu_{13} + 3\mu_{14}$
~~(d)~~ $-\mu_{21} - \mu_{22} + \mu_{23} + \mu_{24} - \mu_{11} - \mu_{12} + \mu_{13} + \mu_{14}$
~~(e)~~ $-\mu_{11} - \mu_{12} + \mu_{13} + \mu_{14}$

(ii) The interaction between Type and Thickness is not significant. Which of the following contrasts evaluate a linear trend in the mean absorption time across the levels of wall thickness?

(a) $-3\mu_{21} - \mu_{22} + \mu_{23} + 3\mu_{24}$
(b) $-3\mu_{21} - \mu_{22} + \mu_{23} + 3\mu_{24} - 3\mu_{11} - \mu_{12} + \mu_{13} + 3\mu_{14}$
(c) $-3\mu_{11} - \mu_{12} + \mu_{13} + 3\mu_{14}$
(d) $-\mu_{21} - \mu_{22} + \mu_{23} + \mu_{24} - \mu_{11} - \mu_{12} + \mu_{13} + \mu_{14}$
(e) $-\mu_{11} - \mu_{12} + \mu_{13} + \mu_{14}$

(8.) A manufacturer of commercial fishing nets produces the net material on a large number of machines. The company would like the machines to be as homogeneous as possible in order to produce netting that has a very uniform strength. The company is concerned that there is considerable amount of material that must be discarded, reworked, or downgraded to a lower quality product. This results in loss of revenue to the company. The process engineer, after examining the maintenance records of the machines, suspects that there may be a larger variation in material strength between machines relative to the usual variation in material produced from the same machine.Estimated values of two sources of variations, σ_M^2 (the variability due to Machine Difference) and σ_e^2 (the background noise or variability in the process) are 0.69 and 0.15, respectively. Which of the following is the proportion of the total variation in the strength measurements attributed to the differences in the machines ?

A. 0.15
B. 0.18
C. 0.69
D. 0.82
E. 0.84

$\sigma_y^2 = 0.69 + 0.15 = 0.84$

$\frac{\sigma_M^2}{\sigma_y^2} = \frac{0.69}{0.84} = 0.9211$

(9.) Which of the following is not one of the basic assumptions made in linear models?

A. the t treatment populations have a normal distribution
B. the t treatment populations have the same standard deviation
C. normality of the residual should be checked by shapiro wilk test
D. the experiments are conducted so that the observed data values are independent
$\boxed{\text{E.}}$ the t treatment populations have any continuous distribution

(10.) A researcher is designing an experiment having 2 factors: Factor F_1 with 2 fixed levels and Factor F_2 with 4 fixed levels. The researcher wants the power of an $\alpha = .01$ F-test to be at least 80% to detect a difference of at least 18 units in one or more pairs of the treatment means. An estimate $\hat{\sigma}_e = 9$ is provided. If the researcher uses $r = 9$ replications per treatment, will this experiment achieve the desired power?

~~(a)~~ 9 reps are sufficient to achieve the desired power because the power is between 0.6 and 0.8 → no, power will be ≠ 0.80

~~(b)~~ 9 reps are sufficient to achieve the desired power because the power is greater than 0.8

(c) We need 25 reps to achieve the desired power

~~(d)~~ 9 reps are not sufficient to achieve the desired power because the power is greater than 0.8

(e) 9 reps are not sufficient to achieve the desired power because the power is between 0.6 and 0.8

$a=2, b=4 \Rightarrow t=8$, $\alpha=0.01$, $\gamma=0.80$, $D=18$, $\hat{\sigma}_e=9$, $r=9$

$$\lambda = \frac{9(18)^2}{2(9)^2} = 18 \Rightarrow \Phi = \sqrt{\lambda/t} = \sqrt{18/8} = 1.5$$

if $r=25$: $\lambda = \frac{25(18)^2}{2(9)^2} = 50$

$\Phi = \sqrt{50/8} = 2.5$

$\gamma \approx 0.98$

$$\nu_2 = n - t = rt - t = 9(8) - 8 = 64$$

$\Rightarrow \gamma \approx 0.50$

(11.) Which of the following is not a correct statement?

~~(a)~~ Kruskal Wallis test is used for testing the research hypothesis that there is a shift difference in the t treatment populations

~~(b)~~ Kruskal Wallis test is a generalization of the Wilcoxon Rank Sum procedure

~~(c)~~ Kruskal Wallis test retains all the conditions required of the AOV F-test except the normality condition

(d) Kruskal Wallis test tends to be more powerful than the F test when the data are normally distributed.

~~(e)~~ Kruskal Wallis test tends to be less powerful than the F test when the data are normally distributed.

(12.) In an experiment involving two factors, factor F1 with fixed qualitative levels and factor F2 with quantitative levels, there was not significant evidence of an interaction between F1 and F2. The experimenter wants to compare the mean responses across the levels of factor F1. Which of the following is the appropriate way to approach this?

A. Tukey's comparison technique applied to the levels of factor F1 averaged over the levels of factor F2

B. Tukey's comparison technique applied to the levels of factor F2 averaged over the levels of factor F1

C. Tukey's comparison technique applied to the levels of factor F1 at each level of F2

D. Tukey's comparison technique applied to the levels of factor F2 at each level of F1

e. None of the above is an appropriateapproach

(13.) A CRD factorial experiment involving three factors (F_1, F_2, F_3) was conducted. $F_1 * F_2 * F_3$ was significant, $F_1 * F_3, F_1 * F_2$ were not significant, but $F_2 * F_3, F_1, F_2, and F_3$ were significant. (levels of F2, F3 are qualitative, levels of F1 is quantitative). The experimenter wants to evaluate trends in the levels of factor F1. Which is the BEST way to answer experiments's quesion?

A. Dunnett's comparison technique applied to the levels of factor F1 separately at each combination of (F2, F3)

B. Hsu's comparison technique applied to the levels of factor F1 averaged over the levels of (F2, F3)

C. Trend analysis in the levels of F1 at each combination of (F2, F3)

D. Tukey's comparison technique applied to the levels of factor F1 separately at each combination of (F2, F3)

e. Comparison of marginal means is not appropriate

Exam II - Spring 2022

The GLM Procedure

Class Level Information		
Class	Levels	Values
M	2	M1 M2
T	3	25 50 75
H	3	45 60 85

Number of Observations Read	36
Number of Observations Used	36

Exam II - Spring 2022

The GLM Procedure

Dependent Variable: G Fungus Growth

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	17	1956.790000	115.105294	24.83	<.0001
Error	18	83.440000	4.635556		
Corrected Total	35	2040.230000			

R-Square	Coeff Var	Root MSE	G Mean
0.959103	15.85056	2.153034	13.58333

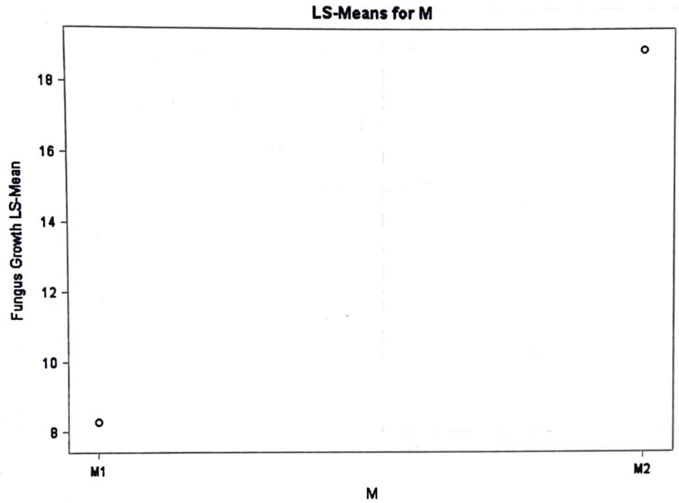
Source	DF	Type III SS	Mean Square	F Value	Pr > F
M	1	1009.121111	1009.121111	217.69	<.0001
T	2	86.281667	43.140833	9.31	0.0017
H	2	540.586667	270.293333	58.31	<.0001
T*H	4	34.916667	8.729167	1.88	0.1572
M*T	2	123.810556	61.905278	13.35	0.0003
M*H	2	132.628889	66.314444	14.31	0.0002
M*T*H	4	29.444444	7.361111	1.59	0.2205

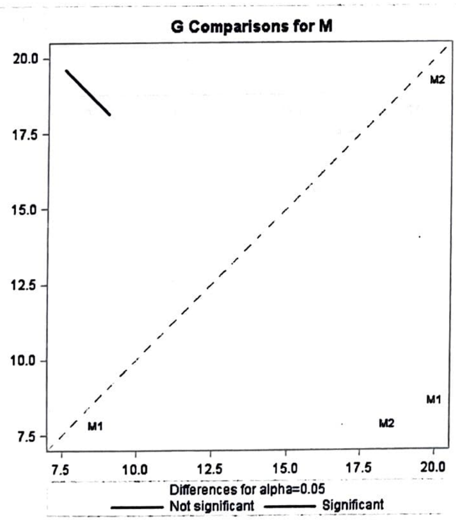
- 2 two-factor interactions are significant

Exam II - Spring 2022

The GLM Procedure
Least Squares Means

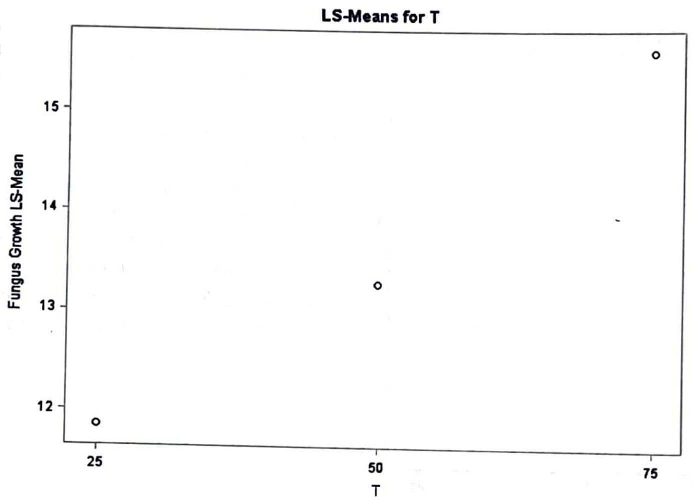
M	G LSMEAN	Standard Error	H0:LSMEAN=0 Pr > |t|	H0:LSMean1=LSMean2 Pr > |t|
M1	8.2888889	0.5074750	<.0001	<.0001
M2	18.8777778	0.5074750	<.0001	

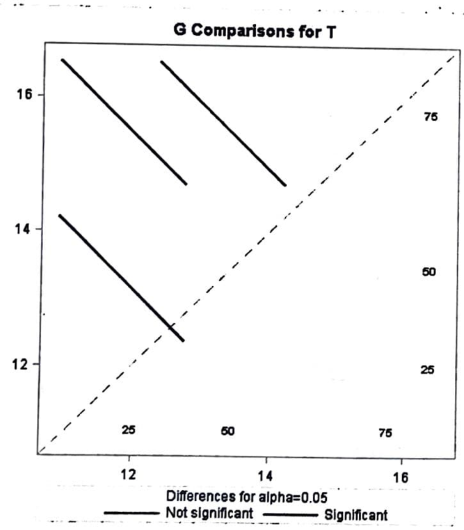




T	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
25	11.8500000	0.6215274	<.0001	1
50	13.2916667	0.6215274	<.0001	2
75	15.6083333	0.6215274	<.0001	3

Least Squares Means for effect T Pr > |t| for H0: LSMean(i)=LSMean(j) Dependent Variable: G			
i/j	1	2	3
1		0.1183	0.0005
2	0.1183		0.0168
3	0.0005	0.0168	





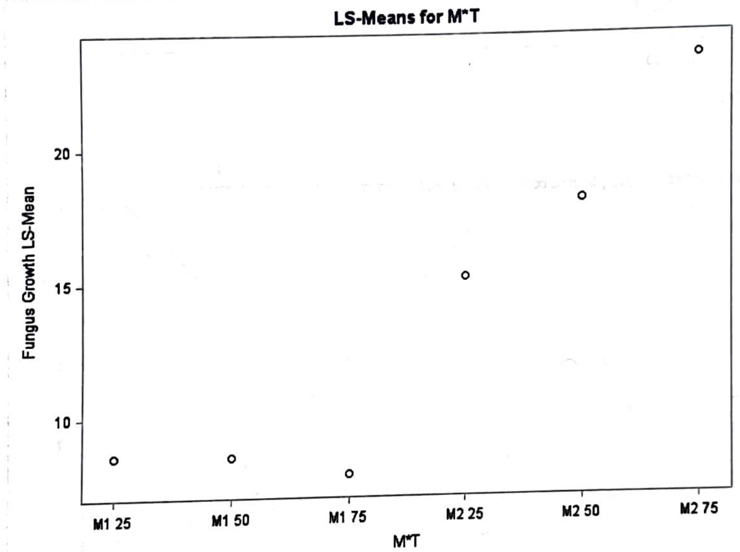
Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

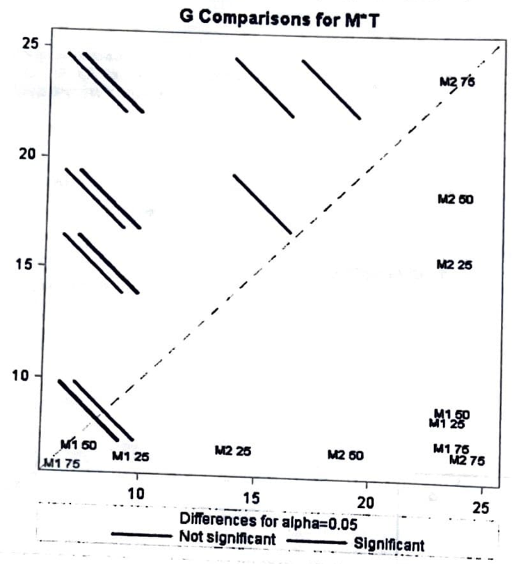
M	T	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
M1	25	8.5333333	0.8789725	<.0001	1
M1	50	8.5000000	0.8789725	<.0001	2

M1	75	7.8333333	0.8789725	<.0001		3
M2	25	15.1666667	0.8789725	<.0001		4
M2	50	18.0833333	0.8789725	<.0001		5
M2	75	23.3833333	0.8789725	<.0001		6

Least Squares Means for effect M*T
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: G

i/j	1	2	3	4	5	6
1		0.9789	0.5803	<.0001	<.0001	<.0001
2	0.9789		0.5983	<.0001	<.0001	<.0001
3	0.5803	0.5983		<.0001	<.0001	<.0001
4	<.0001	<.0001	<.0001		0.0306	<.0001
5	<.0001	<.0001	<.0001	0.0306		0.0005
6	<.0001	<.0001	<.0001	<.0001	0.0005	



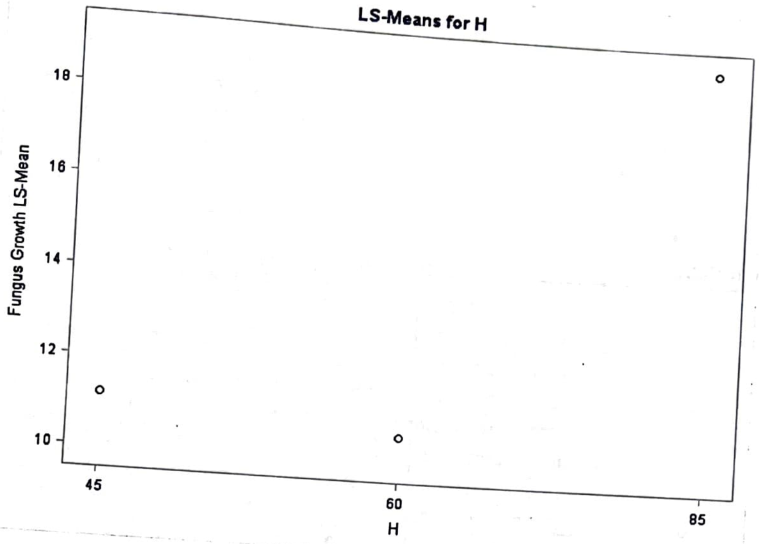


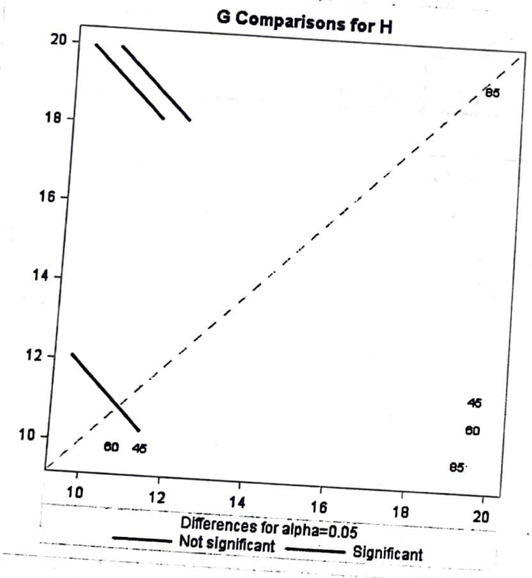
Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

H	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
45	11.1833333	0.6215274	<.0001	1
60	10.5166667	0.6215274	<.0001	2
85	19.0500000	0.6215274	<.0001	3

Least Squares Means for effect H
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: G

i/j	1	2	3
1		0.4580	<.0001
2	0.4580		<.0001
3	<.0001	<.0001	



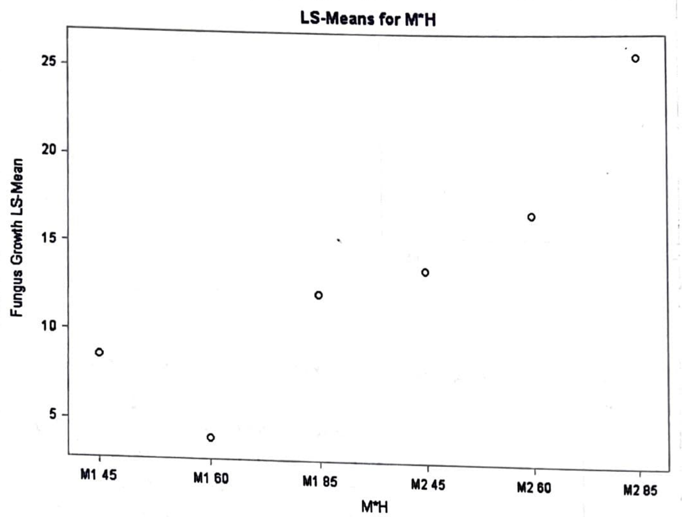


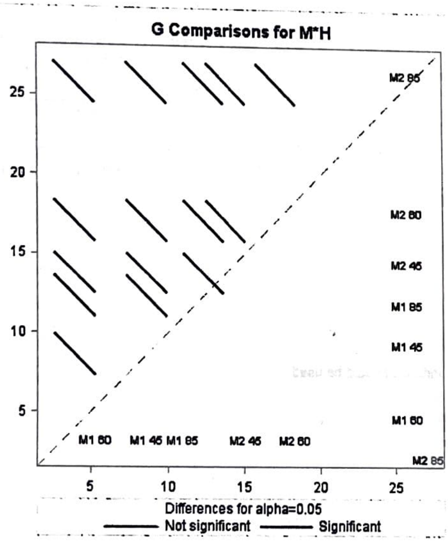
Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

M	H	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
M1	45	8.6000000	0.8789725	<.0001	1
M1	60	3.9833333	0.8789725	0.0003	2
M1	85	12.2833333	0.8789725	<.0001	3
M2	45	13.7666667	0.8789725	<.0001	4
M2	60	17.0500000	0.8789725	<.0001	5
M2	85	25.8166667	0.8789725	<.0001	6

Least Squares Means for effect M*H
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: G

i/j	1	2	3	4	5	6
1		0.0016	0.0083	0.0006	<.0001	<.0001
2	0.0016		<.0001	<.0001	<.0001	<.0001
3	0.0083	<.0001		0.2482	0.0012	<.0001
4	0.0006	<.0001	0.2482		0.0166	<.0001
5	<.0001	<.0001	0.0012	0.0166		<.0001
6	<.0001	<.0001	<.0001	<.0001	<.0001	





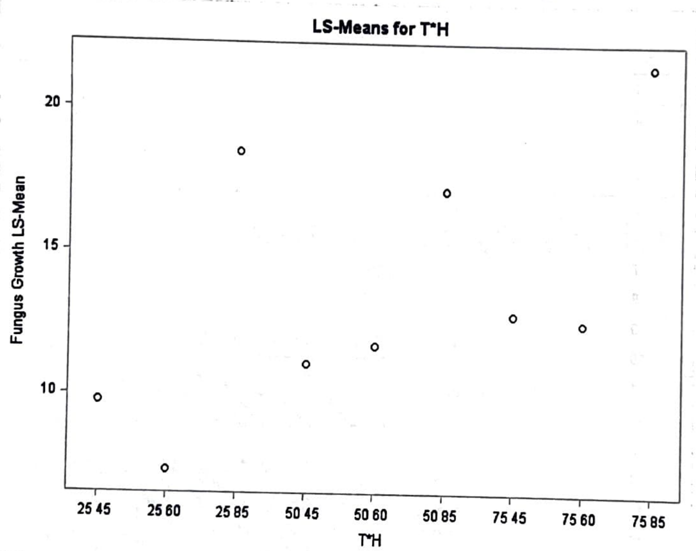
Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

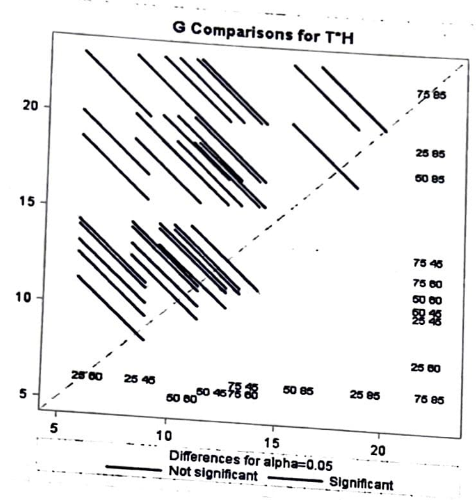
T	H	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
25	45	9.7500000	1.0765170	<.0001	1

25	60	7.3250000	1.0765170	<.0001	2
25	85	18.4750000	1.0765170	<.0001	3
50	45	11.0250000	1.0765170	<.0001	4
50	60	11.7000000	1.0765170	<.0001	5
50	85	17.1500000	1.0765170	<.0001	6
75	45	12.7750000	1.0765170	<.0001	7
75	60	12.5250000	1.0765170	<.0001	8
75	85	21.5250000	1.0765170	<.0001	9

Least Squares Means for effect T*H
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: G

i/j	1	2	3	4	5	6	7	8	9
1		0.1286	<.0001	0.4133	0.2165	0.0001	0.0624	0.0850	<.0001
2	0.1286		<.0001	0.0258	0.0101	<.0001	0.0021	0.0031	<.0001
3	<.0001	<.0001		0.0001	0.0003	0.3956	0.0015	0.0010	0.0604
4	0.4133	0.0258	0.0001		0.6628	0.0008	0.2654	0.3376	<.0001
5	0.2165	0.0101	0.0003	0.6628		0.0021	0.4892	0.5945	<.0001
6	0.0001	<.0001	0.3956	0.0008	0.0021		0.0101	0.0071	0.0101
7	0.0624	0.0021	0.0015	0.2654	0.4892	0.0101		0.8714	<.0001
8	0.0850	0.0031	0.0010	0.3376	0.5945	0.0071	0.8714		<.0001
9	<.0001	<.0001	0.0604	<.0001	<.0001	0.0101	<.0001	<.0001	





Note: To ensure overall protection level, only probabilities associated with pre-planned comparisons should be used.

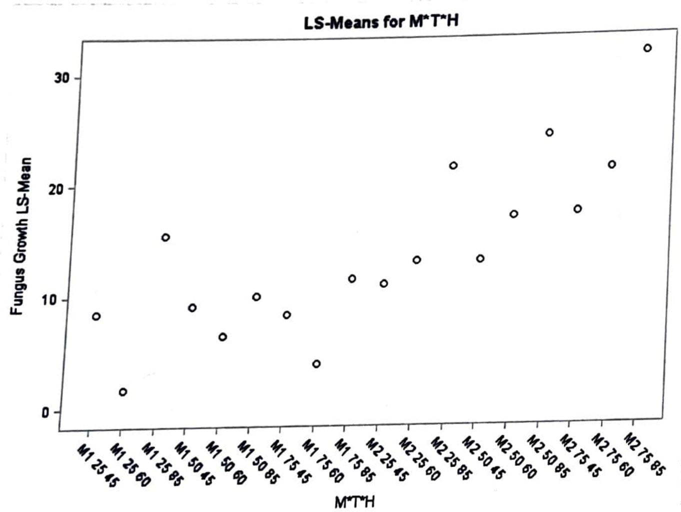
M	T	H	G LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
M1	25	45	8.5000000	1.5224250	<.0001	1
M1	25	60	1.6500000	1.5224250	0.2928	2
M1	25	85	15.4500000	1.5224250	<.0001	3
M1	50	45	9.0500000	1.5224250	<.0001	4
M1	50	60	6.4500000	1.5224250	0.0005	5
M1	50	85	10.0000000	1.5224250	<.0001	6
M1	75	45	8.2500000	1.5224250	<.0001	7
M1	75	60	3.8500000	1.5224250	0.0210	8
M1	75	85	11.4000000	1.5224250	<.0001	9
M2	25	45	11.0000000	1.5224250	<.0001	10
M2	25	60	13.0000000	1.5224250	<.0001	11
M2	25	85	21.5000000	1.5224250	<.0001	12
M2	50	45	13.0000000	1.5224250	<.0001	13
M2	50	60	16.9500000	1.5224250	<.0001	14
M2	50	85	24.3000000	1.5224250	<.0001	15
M2	75	45	17.3000000	1.5224250	<.0001	16
M2	75	60	21.2000000	1.5224250	<.0001	17
M2	75	85	31.6500000	1.5224250	<.0001	18

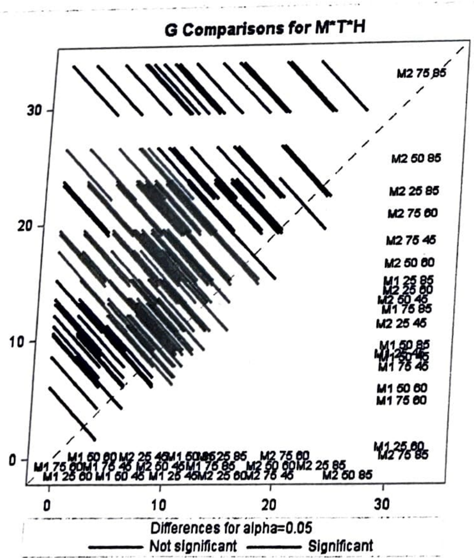
Least Squares Means for effect M*T*H
Pr > |t| for H0: LSMean(i)=LSMean(j)
Dependent Variable: G

i/j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1		0.0052	0.0047	0.8013	0.3536	0.4949	0.9088	0.0445	0.1947	0.2607	0.0511	<.0001	0.0511	0.0010	<.0001	0.0007	<.0001	<.0001
2	0.0052		<.0001	0.0029	0.0388	0.0011	0.0067	0.3204	0.0003	0.0004	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
3	0.0047	<.0001		0.0082	0.0006	0.0209	0.0036	<.0001	0.0762	0.0534	0.2701	0.0116	0.2701	0.4949	0.0007	0.4015	0.0156	<.0001
4	0.8013	0.0029	0.0082		0.2428	0.6643	0.7146	0.0266	0.2895	0.3771	0.0831	<.0001	0.0831	0.0018	<.0001	0.0012	<.0001	<.0001
5	0.3536	0.0388	0.0006	0.2428		0.1165	0.4141	0.2428	0.0337	0.0488	0.0070	<.0001	0.0070	0.0001	<.0001	<.0001	<.0001	<.0001
6	0.4949	0.0011	0.0209	0.6643	0.1165		0.4269	0.0105	0.5237	0.6479	0.1805	<.0001	0.1805	0.0047	<.0001	0.0033	<.0001	<.0001

file:///C:/Users/akleman/AppData/Local/Temp/S

7	0.9088	0.0067	0.0036	0.7146	0.4141	0.4269		0.0559	0.1607	0.2177	0.0406	<.0001	0.0406	0.0008	<.0001	0.0005	<.0001	<.0001
8	0.0445	0.3204	<.0001	0.0266	0.2428	0.0105	0.0559		0.0025	0.0038	0.0005	<.0001	0.0005	<.0001	<.0001	<.0001	<.0001	<.0001
9	0.1947	0.0003	0.0762	0.2895	0.0337	0.5237	0.1607	0.0025		0.8547	0.4670	0.0002	0.4670	0.0190	<.0001	0.0134	0.0002	<.0001
10	0.2607	0.0004	0.0534	0.3771	0.0488	0.6479	0.2177	0.0038	0.8547		0.3652	0.0001	0.3652	0.0128	<.0001	0.0090	0.0002	<.0001
11	0.0511	<.0001	0.2701	0.0831	0.0070	0.1805	0.0406	0.0005	0.4670	0.3652		0.0009	1.0000	0.0831	<.0001	0.0612	0.0013	<.0001
12	<.0001	<.0001	0.0116	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	0.0001	0.0009		0.0009	0.0488	0.2098	0.0668	0.8907	0.0002
13	0.0511	<.0001	0.2701	0.0831	0.0070	0.1805	0.0406	0.0005	0.4670	0.3652	1.0000	0.0009		0.0831	<.0001	0.0612	0.0013	<.0001
14	0.0010	<.0001	0.4949	0.0018	0.0001	0.0047	0.0008	<.0001	0.0190	0.0128	0.0831	0.0488	0.0831		0.0031	0.8727	0.0639	<.0001
15	<.0001	<.0001	0.0007	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.2098	<.0001	0.0031		0.0044	0.1671	0.0031
16	0.0007	<.0001	0.4015	0.0012	<.0001	0.0033	0.0005	<.0001	0.0134	0.0090	0.0612	0.0668	0.0612	0.8727	0.0044		0.0868	<.0001
17	<.0001	<.0001	0.0156	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	0.0002	0.0013	0.8907	0.0013	0.0639	0.1671	0.0868		0.0001
18	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	0.0002	<.0001	<.0001	0.0031	<.0001	0.0001	





Exam II - Spring 2022

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
TRT	18	TRT01 TRT02 TRT03 TRT04 TRT05 TRT06 TRT07 TRT08 TRT09 TRT10 TRT11 TRT12 TRT13 TRT14 TRT15 TRT16 TRT17 TRT18

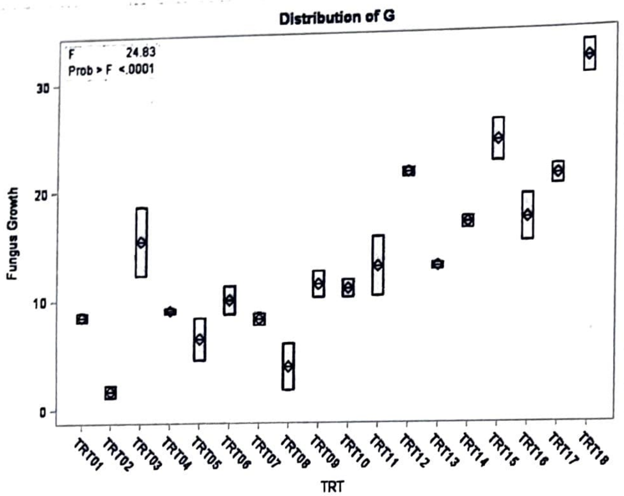
Number of Observations Read	36
Number of Observations Used	36

Error	18	83.440000	4.635556
Corrected Total	35	2040.230000	

R-Square	Coeff Var	Root MSE	G Mean
0.959103	15.85056	2.153034	13.58333

Source	DF	Type I SS	Mean Square	F Value	Pr > F
TRT	17	1956.790000	115.105294	24.83	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
TRT	17	1956.790000	115.105294	24.83	<.0001



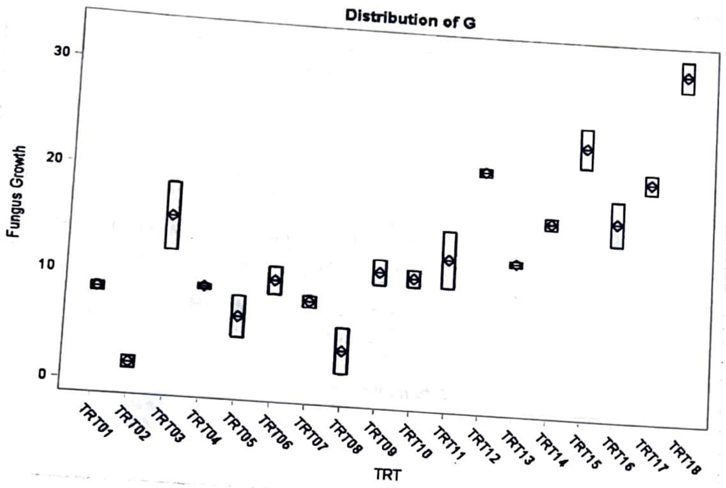
Exam II - Spring 2022

The GLM Procedure

Brown and Forsythe's Test for Homogeneity of G Variance ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
TRT	0	0	.	.	.
Error	0	0	.		

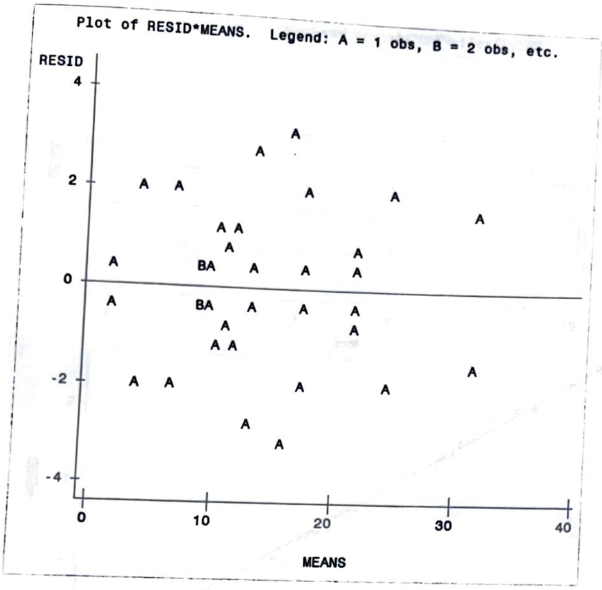
Exam II - Spring 2022

The GLM Procedure



Level of TRT	N	G	
		Mean	Std Dev
TRT01	2	8.5000000	0.56568542
TRT02	2	1.6500000	0.77781746
TRT03	2	15.4500000	4.45477272
TRT04	2	9.0500000	0.35355339
TRT05	2	6.4500000	2.75771645
TRT06	2	10.0000000	1.83847763
TRT07	2	8.2500000	0.77781746
TRT08	2	3.8500000	3.04055916
TRT09	2	11.4000000	1.69705627
TRT10	2	11.0000000	1.13137085
TRT11	2	13.0000000	3.81837662
TRT12	2	21.5000000	0.56568542
TRT13	2	13.0000000	0.42426407
TRT14	2	16.9500000	0.77781746
TRT15	2	24.3000000	2.68700577
TRT16	2	17.3000000	2.96984848
TRT17	2	21.2000000	1.27279221
TRT18	2	31.6500000	2.05060967

Exam II - Spring 2022



Exam II - Spring 2022

The UNIVARIATE Procedure
Variable: RESID

Moments			
N	36	Sum Weights	36
Mean	0	Sum Observations	0
Std Deviation	1.54402073	Variance	2.384
Skewness	0	Kurtosis	-0.5222252
Uncorrected SS	83.44	Corrected SS	83.44
Coeff Variation	.	Std Error Mean	0.25733679

Basic Statistical Measures			
Location		Variability	
Mean	0	Std Deviation	1.54402
Median	-355E-17	Variance	2.38400
Mode	.	Range	6.30000
		Interquartile Range	2.10000

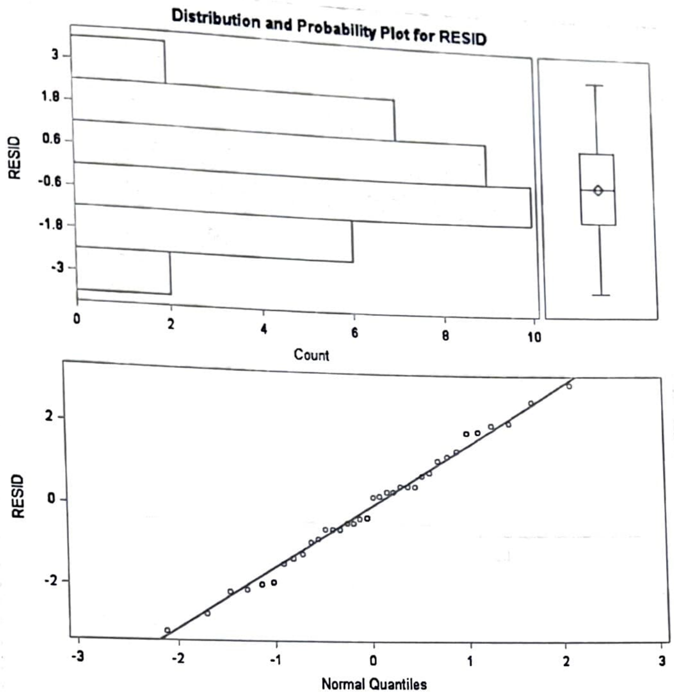
Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	0	Pr > |t|	1.0000
Sign	M	0	Pr >= |M|	1.0000
Signed Rank	S	0.5	Pr >= |S|	0.9939

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.987725	Pr < W	0.9536
Kolmogorov-Smirnov	D	0.064314	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.023238	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.151118	Pr > A-Sq	>0.2500

Quantiles (Definition 5)	
Level	Quantile
100% Max	3.15
99%	3.15
95%	2.70
90%	2.10
75% Q3	1.05
50% Median	-0.00
25% Q1	-1.05
10%	-2.10
5%	-2.70
1%	-3.15
0% Min	-3.15

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
-3.15	6	1.95	10
-2.70	22	2.10	32
-2.15	16	2.15	15
-2.10	31	2.70	21

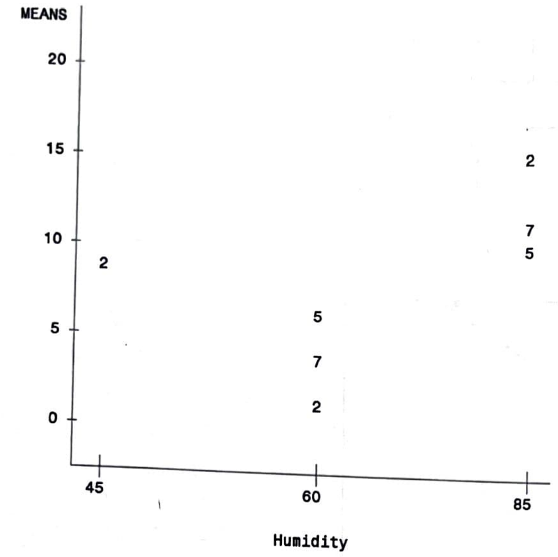
-1.95	9	3.15	5


Distribution and Probability Plot for RESID
RESID
Count
Normal Quantiles

Exam II - Spring 2022

Growth Media=M1

Plot of MEANS*H. Symbol is value of T.



NOTE: 11 obs hidden.