Question 1.

Data:

Treatment	A	B	C	Data		mean	A	B	C	AB	AC	BC	ABC
(1)	−	−	−	50	54	$\bar{y}_{111.} = 52$	-1	-1	-1	1	1	1	-1
a	+	−	−	44	42	$\bar{y}_{211.} = 43$	1	-1	-1	-1	-1	1	1
b	−	+	−	46	48	$\bar{y}_{121.} = 47$	-1	1	-1	-1	1	-1	1
ab	+	+	−	42	43	$\bar{y}_{221.} = 42.5$	1	1	-1	1	-1	-1	-1
c	−	−	+	49	46	$\bar{y}_{112.} = 47.5$	-1	-1	1	1	-1	-1	1
ac	+	−	+	48	45	$\bar{y}_{212.} = 46.5$	1	-1	1	-1	1	-1	-1
bc	−	+	+	47	48	$\bar{y}_{122.} = 47.5$	-1	1	1	-1	-1	1	-1
abc	+	+	+	56	24	$\bar{y}_{222.} = 55$	1	1	1	1	1	1	1

$\bar{y}_{....} = 47.625$

50/50

The Factor Effects model:

$$y_{ijkl} = \mu + \tau_i + \beta_j + \gamma_k + (\tau\beta)_{ij} + (\tau\gamma)_{ik} + (\beta\gamma)_{jk} + (\tau\beta\gamma)_{ijk} + \epsilon_{ijkl},$$

μ: overall population mean

τ_i ($i=1,2$) effect of ith level of Factor A

β_j ($j=1,2$) effect of jth level of Factor B

γ_k ($k=1,2$) effect of kth level of Factor C

$(\tau\beta)_{ij}$: effect of ith level of Factor A and jth level of Factor B

$(\tau\gamma)_{ik}$: effect of ith level of Factor A and kth level of Factor C

$(\beta\gamma)_{jk}$: effect of jth level of Factor B and kth level of Factor C

$(\tau\beta\gamma)_{ijk}$: effect of ith level of Factor A and jth level of Factor B and kth level of Factor C

ϵ_{ijkl}: random error of lth experimental unit from ith level of Factor A and jth level of Factor B and kth level of factor C. ($n=1,2,$)

$\hat{\mu} = \bar{y}_{....} = 47.625$

$y_{1...} = 48.5$ $\quad y_{11..} = 49.75$

$y_{2...} = 46.75$ $\quad y_{1.1.} = 49.5$

$y_{.1..} = 47.25$ $\quad y_{.11.} = 47.5$

$y_{.2..} = 48$

$y_{..1.} = 46.125$

$y_{..2.} = 49.125$

Effect $= \frac{1}{2^{k-1}}$ Contrast $\quad k=3$, $n=2$

$SS_\theta = 2^{k-2} \cdot n \cdot (\text{Effect})^2$

a): $\tau_1 = \bar{y}_{1\cdots} - \bar{y}_{\cdots} = 0.875 = -\tau_2$ $\quad A = -2\times 0.875 = -1.75$ $\quad A = 2\tau_2$

$\beta_1 = \bar{y}_{\cdot 1\cdot\cdot} - \bar{y}_{\cdots} = -0.375 = -\beta_2$ $\quad B = 2\times 0.375 = 0.75$ $\quad B = 2\beta_2$

$\gamma_1 = \bar{y}_{\cdot\cdot 1\cdot} - \bar{y}_{\cdots} = -1.5 = -\gamma_2$ $\quad C = 2\times 1.5 = 3$ $\quad C = 2\gamma_2$

$(\tau\beta)_{11} = \bar{y}_{11\cdot\cdot} - \bar{y}_{1\cdots} - \bar{y}_{\cdot 1\cdot\cdot} - \bar{y}_{\cdots} = 1.625$ $\quad AB = 2\times 1.625 = 3.25$ $\quad AB = 2(\tau\beta)_{11}$

$(\tau\gamma)_{11} = \bar{y}_{1\cdot 1\cdot} - \bar{y}_{1\cdots} - \bar{y}_{\cdot\cdot 1\cdot} - \bar{y}_{\cdots} = 2.5$ $\quad AC = 2\times 2.5 = 5$ $\quad AC = 2(\tau\gamma)_{11}$

$(\beta\gamma)_{11} = \bar{y}_{\cdot 11\cdot} - \bar{y}_{\cdot 1\cdot\cdot} - \bar{y}_{\cdot\cdot 1\cdot} - \bar{y}_{\cdots} = 1.75$ $\quad BC = 2\times 1.75 = 3.5$ $\quad BC = 2(\beta\gamma)_{11}$

$(\tau\beta\gamma)_{111} = \bar{y}_{111\cdot} - \bar{y}_{1\cdots} - \bar{y}_{\cdot 1\cdot\cdot} - \bar{y}_{\cdot\cdot 1\cdot} + \bar{y}_{\cdots}$ $\quad ABC = 1$

$A = \frac{1}{2^{3-1}}(-52+43-47+42.5-47.5+46.5-47.5+55) = -1.75$

$B = \frac{1}{2^{3-1}}(-52-43+47+42.5-47.5-46.5+47.5+55) = 0.75$

$C = \frac{1}{2^{3-1}}(-52-43-47-42.5+47.5+46.5+47.5+55) = 3$

$AB = \frac{1}{2^{3-1}}(52-43-47+42.5+47.5-46.5-47.5+55) = 3.25$ ✓

$AC = \frac{1}{2^{3-1}}(52-43+47-42.5-47.5+46.5-47.5+55) = 5$

$BC = \frac{1}{2^{3-1}}(52+43-47-42.5-47.5-46.5+47.5+55) = 3.5$

$ABC = \frac{1}{2^{3-1}}(-52+43+47-42.5+47.5-46.5-47.5+55) = 1$

$\hat{\theta} = \frac{1}{2^k}$ contrast

Effect $= \frac{1}{2^{k-1}}$ contrast

$n=2$

b) $SS_A = 2n(A)^2 = 2\times 2\times 1.75^2 = 12.25$

$SS_B = 2n(B)^2 = 2\times 2\times 0.75^2 = 2.25$

$SS_C = 2n(C)^2 = 2\times 2\times 3^2 = 36$

$SS_{AB} = 2n(AB)^2 = 2\times 2\times 3.25^2 = 42.25$ ✓

$SS_{AC} = 2n(AC)^2 = 2\times 2\times 5^2 = 100$

$SS_{BC} = 2n(BC)^2 = 2\times 2\times 3.5^2 = 49$

$SS_{ABC} = 2n(ABC)^2 = 2\times 2\times 1 = 4$

$SS_\theta = 2^{k-2}\cdot n\cdot(\text{Effect})^2$

Source of variation	df	SS	MS = SS/df	F
Factor A	1	12.25	12.25	4.083
Factor B	1	2.25	2.25	0.75
Factor C	1	36	36	12
Interaction AB	1	42.25	42.25	14.083 ✓
Interaction AC	1	49	49	16.333
Interaction BC	1	100	100	33.333
Interaction ABC	1	4	4	1.333
Error	8	24	3	
Total	15	269.75		

c). $Var(\theta) = \frac{\sigma^2}{2^k n}$ $\quad \sigma^2 = MSE = 3$ $\quad Var(Effect) = \frac{\sigma^2}{2^{k-2} n}$

$k=3$

$n=2$

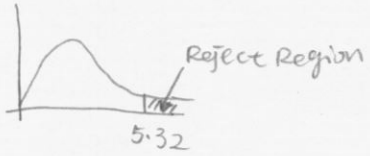
$= \frac{3}{2^3 \times 2}$

$= 0.1875$

$= \frac{3}{2^{3-2} \cdot 2} = 0.75$ ✓

d). $H_0: \tau_i = 0 \ \forall i$ $\quad H_a: \tau_i \neq 0$ for at least one i

$F_{\alpha,1,8} = 5.32$



$F_A = 4.083 < 5.32$ ✓

Fail to reject H_0.

Similary,

$F_B = 0.75 < 5.32$

Fail to Reject H_0.

$F_C = 12 > 5.32$, Reject H_0. Effect C is significant.

$H_0: (\tau\beta)_{ij} = 0 \ \forall i,j$ $\quad H_a: (\tau\beta)_{ij} \neq 0$ for at least one (i,j)

$F_{AB} = 14.083 > 5.32$, Reject H_0. Effect AB is significant.

Similarly,

$F_{AC} = 16.333 > 5.32$, Reject H_0. Effect AC is significant. ✓

$F_{BC} = 33.333 > 5.32$, Reject H_0. Effect BC is significant

$H_0: (\tau\beta\gamma)_{ijk} = 0 \ \forall ijk$ $\quad H_a: (\tau\beta\gamma)_{ijk} \neq 0$ for at least one (i,j,k)

$F_{ABC} = 1.333 < 5.32$

Fail to Reject H_0.

Among All the effects of A B C AB AC BC ABC,

Effects of C, AB, AC, BC are significant. ✓

Question 2

a) $BCE = \frac{1}{2^{k-1}}(\text{contrast})$

$= \frac{1}{2^4}(-8.11 - 7.93 - 5.82 - 12.00 - 9.17 - 9.86 - 5.69 - 11.61 - 14.23 - 17.55 - 9.2 - 8.87 - 11.49$
$- 18.83 - 6.25 - 11.78 + 5.56 + 5.00 + 5.77 + 7.47 + 7.8 + 3.65 + 3.23 + 6.40 + 8.82$
$+ 12.43 + 8.94 + 25.58 + 8.68 + 13.06 + 9.12 + 26.05)$

$= \frac{1}{16} \times (-10.83)$

$= -0.676875$ ✓

$\doteq -0.6769$

b). SAS code and output See Attached File. ✓

c). The largest 10 points in Q-Q plot,

because these 10 points deviate from straight line indicate potential significance. ✓

ABE AB ABC BC AC AE B BE A E

Question 2 a) to calculate BCE

Obs	trt	A		B		C	D	E	y	BCD		BCE	
1	-1	-1	-8.11	-1	-8.11	-1	-1	-1	8.11	-1	-8.11	-1	-8.11
2	a	1	7.93	-1	-7.93	-1	-1	-1	7.93	-1	-7.93	-1	-7.93
3	b	-1	-5.56	1	5.56	-1	-1	-1	5.56	1	5.56	1	5.56
4	ab	1	5	1	5	-1	-1	-1	5	1	5	1	5
5	c	-1	-5.77	-1	-5.77	1	-1	-1	5.77	1	5.77	1	5.77
6	ac	1	7.47	-1	-7.47	1	-1	-1	7.47	1	7.47	1	7.47
7	bc	-1	-5.82	1	5.82	1	-1	-1	5.82	-1	-5.82	-1	-5.82
8	abc	1	12	1	12	1	-1	-1	12	-1	-12	-1	-12
9	d	-1	-9.17	-1	-9.17	-1	1	-1	9.17	1	9.17	-1	-9.17
10	ad	1	9.86	-1	-9.86	-1	1	-1	9.86	1	9.86	-1	-9.86
11	bd	-1	-7.8	1	7.8	-1	1	-1	7.8	-1	-7.8	1	7.8
12	abd	1	3.65	1	3.65	-1	1	-1	3.65	-1	-3.65	1	3.65
13	cd	-1	-3.23	-1	-3.23	1	1	-1	3.23	-1	-3.23	1	3.23
14	acd	1	6.4	-1	-6.4	1	1	-1	6.4	-1	-6.4	1	6.4
15	bcd	-1	-5.69	1	5.69	1	1	-1	5.69	1	5.69	-1	-5.69
16	abcd	1	11.61	1	11.61	1	1	-1	11.61	1	11.61	-1	-11.61
17	e	-1	-8.82	-1	-8.82	-1	-1	1	8.82	-1	-8.82	1	8.82
18	ae	1	12.43	-1	-12.43	-1	-1	1	12.43	-1	-12.43	1	12.43
19	be	-1	-14.23	1	14.23	-1	-1	1	14.23	1	14.23	-1	-14.23
20	abe	1	17.55	1	17.55	-1	-1	1	17.55	1	17.55	-1	-17.55
21	ce	-1	-9.2	-1	-9.2	1	-1	1	9.2	1	9.2	-1	-9.2
22	ace	1	8.87	-1	-8.87	1	-1	1	8.87	1	8.87	-1	-8.87
23	bce	-1	-8.94	1	8.94	1	-1	1	8.94	-1	-8.94	1	8.94
24	abce	1	25.58	1	25.58	1	-1	1	25.58	-1	-25.58	1	25.58
25	de	-1	-8.68	-1	-8.68	-1	1	1	8.68	1	8.68	1	8.68
26	ade	1	13.06	-1	-13.06	-1	1	1	13.06	1	13.06	1	13.06
27	bde	-1	-11.49	1	11.49	-1	1	1	11.49	-1	-11.49	-1	-11.49
28	abde	1	18.83	1	18.83	-1	1	1	18.83	-1	-18.83	-1	-18.83
29	cde	-1	-6.25	-1	-6.25	1	1	1	6.25	-1	-6.25	-1	-6.25
30	acde	1	11.78	-1	-11.78	1	1	1	11.78	-1	-11.78	-1	-11.78
31	bcde	-1	-9.12	1	9.12	1	1	1	9.12	1	9.12	1	9.12
32	abcde	1	26.05	1	26.05	1	1	1	26.05	1	26.05	1	26.05
			70.19		51.89						7.83		-10.83
			4.386875		3.243125						0.489375		-0.676875

d) SAS code & output See Attached File ✓

e)
A
B
E
AB
AC
AE
BC
BE
ABC
ABE

P-value < 0.05

Thus, Reject H_0.

There's enough evidence to claim H_a. ✓

Thus, all these effects are significant.

f). Normality: by QQ plot all the errors close to one straight Line ✓.

Constant Variance: by plot of residuals and fitted values, the points randomly scattered around 0. ok

Independence: by plot of residuals and fitted values, the points randomly scattered ok

→ Indicate assumptions reasonably met based on patterns you observed.

```
ods rtf file='hw4_output_Final.rtf' startpage=NO;
/*Code for reading in (and printing) effect estimates for Problem 2.  You must insert value for
BCE effect estimate before reading the "estimates.csv" file into SAS.
BCE = -10.83/16
*/

/* b) c)*/
data effects;
infile 'estimates.csv' firstobs=2 dsd;
input effect $ estimate;
run;

proc print data=effects;
run;


proc univariate data=effects;
qqplot;
run;


proc sort data=effects;
by estimate;
run;

proc print data=effects;
run;

/*Code for reading in (and printing) data for Problem 2.*/

data obs;
infile 'unrep.csv' firstobs=2 dsd;
input trt $ A B C D E y;
run;

proc print data=obs;
run;

data obs1;
set obs;
AB=A*B;
BC=B*C;
AC=A*C;
AE=A*E;
BE=B*E;
ABE=A*B*E;
ABC=A*B*C;

run;

proc print data=obs1;
run;

proc glm data=obs1;
class A B C E;
model y = A B E AB AC AE BC BE ABC ABE;
run;

/* final model */
proc glm data=obs1 plots=all;
class A B C E;
model y = A B E AB AC AE BC BE ABC ABE;
```

```
run;

ods rtf close;
```

To get the contrast

```
/*Code for reading in (and printing) data for Problem 2.*/
ods rtf file='hw4_output2.rtf' startpage=NO;

data obs;
infile 'unrep.csv' firstobs=2 dsd;
input trt $ A B C D E y;
run;

proc print data=obs;
run;

data obs1;
set obs;
AB=A*B; AC=A*C; AD=A*D; AE=A*E;
BC=B*C; BD=B*D; BE=B*E;
CD=C*D; CE=C*E;
DE=D*E;
ABC=A*B*C;
ABD=A*B*D;
ABE=A*B*E;
ACD=A*C*D;
ACE=A*C*E;
ADE=A*D*E;
BCD=B*C*D;
BCE=B*C*E;
BDE=B*D*E;
CDE=C*D*E;
ABCD=A*B*C*D;
ABCE=A*B*C*E;
ABDE=A*B*D*E;
ACDE=A*C*D*E;
BCDE=B*C*D*E;
ABCDE=A*B*C*D*E;
run;

proc print data=obs1;
run;

proc reg outset=effects data=obs1 plots=none;
model y= A B C D E AB AC AD AE BC BD BE CD CE DE ABC ABD ABE ACD ACE ADE BCD BCE BDE CDE ABCD ABCE
ABDE ACDE BCDE ABCDE;
run;

proc print data=effects;
run;

data effect2;
set effects;
drop _MODEL_ _TYPE_ _DEPVAR_ _RMSE_ Intercept y;
run;

proc print data=effect2;
run;
```

```
proc transpose data=effect2 out=effect3 name=effect;
run;

data effect3;
set effect3(rename=(COL1=estimate));
run;

proc sort data=effect3;
by estimate;
run;

proc print data=effect3;
run;

proc univariate data=effect3;
qqplot;
run;

ods rtf close;
```

The SAS System

Obs	effect	estimate
1	A	4.38688
2	B	3.24313
3	C	0.10063
4	D	-0.03813
5	E	5.98813
6	AB	2.06563
7	AC	2.58063
8	AD	0.58938
9	AE	2.79063
10	BC	2.48688
11	BD	-0.01688
12	BE	3.34438
13	CD	-0.40188
14	CE	-0.01313
15	DE	-0.00688
16	ABC	2.38438
17	ABD	-0.53188
18	ABE	1.81438
19	ACD	0.33063
20	ACE	-0.06563
21	ADE	0.77813
22	BCD	0.48938
23	BCE	-0.67688
24	BDE	-0.14063
25	CDE	0.59938
26	ABCD	-0.38063
27	ABCE	0.82813
28	ABDE	0.24188
29	ACDE	-0.16063
30	BCDE	-0.15938
31	ABCDE	-0.72188

The UNIVARIATE Procedure
Variable:
estimate

The SAS System

Moments			
N	31	**Sum Weights**	31
Mean	1.0234879	**Sum Observations**	31.728125
Std Deviation	1.65598429	**Variance**	2.74228398
Skewness	1.31916755	**Kurtosis**	1.32572365
Uncorrected SS	114.741871	**Corrected SS**	82.2685194
Coeff Variation	161.79813	**Std Error Mean**	0.29742356

Basic Statistical Measures			
Location		**Variability**	
Mean	1.023488	**Std Deviation**	1.65598
Median	0.330625	**Variance**	2.74228
Mode	.	**Range**	6.71000
		Interquartile Range	2.52500

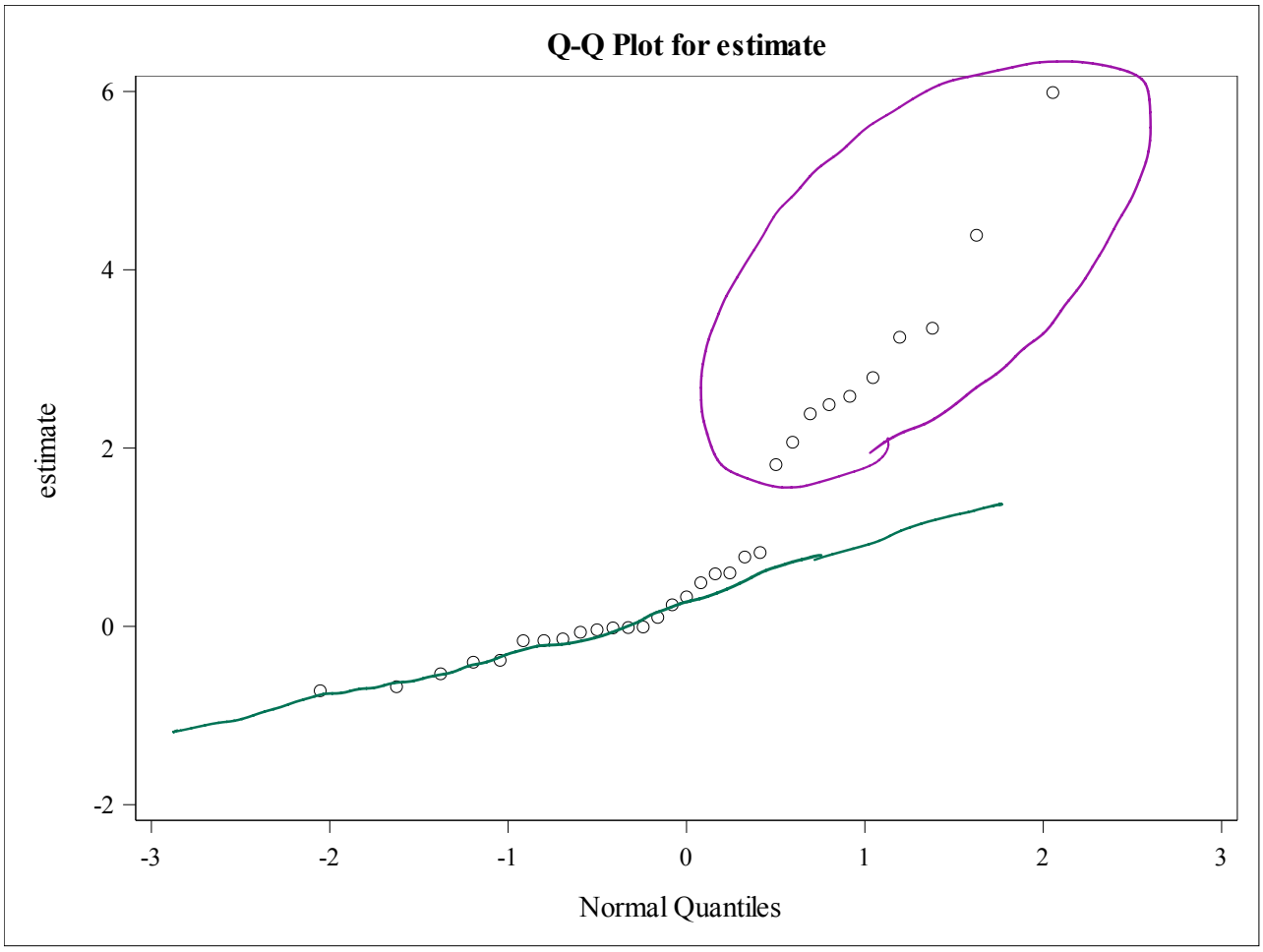
Tests for Location: Mu0=0				
Test	**Statistic**		**p Value**	
Student's t	**t**	3.44118	**Pr > |t|**	0.0017
Sign	**M**	2.5	**Pr >= |M|**	0.4731
Signed Rank	**S**	132	**Pr >= |S|**	0.0074

Quantiles (Definition 5)	
Level	**Quantile**
100% Max	5.988125
99%	5.988125
95%	4.386875
90%	3.243125
75% Q3	2.384375
50% Median	0.330625
25% Q1	-0.140625
10%	-0.401875
5%	-0.676875
1%	-0.721875
0% Min	-0.721875

The SAS System

Extreme Observations			
Lowest		Highest	
Value	Obs	Value	Obs
-0.721875	31	2.79063	9
-0.676875	23	3.24313	2
-0.531875	17	3.34438	12
-0.401875	13	4.38688	1
-0.380625	26	5.98813	5

The UNIVARIATE Procedure



Obs	effect	estimate
1	ABCDE	-0.72188
2	BCE	-0.67688
3	ABD	-0.53188
4	CD	-0.40188
5	ABCD	-0.38063

The SAS System

Obs	effect	estimate
6	ACDE	-0.16063
7	BCDE	-0.15938
8	BDE	-0.14063
9	ACE	-0.06563
10	D	-0.03813
11	BD	-0.01688
12	CE	-0.01313
13	DE	-0.00688
14	C	0.10063
15	ABDE	0.24188
16	ACD	0.33063
17	BCD	0.48938
18	AD	0.58938
19	CDE	0.59938
20	ADE	0.77813
21	ABCE	0.82813
22	ABE	1.81438
23	AB	2.06563
24	ABC	2.38438
25	BC	2.48688
26	AC	2.58063
27	AE	2.79063
28	B	3.24313
29	BE	3.34438
30	A	4.38688
31	E	5.98813

c). significant effects

Obs	trt	A	B	C	D	E	y
1	(1)	-1	-1	-1	-1	-1	8.11
2	a	1	-1	-1	-1	-1	7.93
3	b	-1	1	-1	-1	-1	5.56
4	ab	1	1	-1	-1	-1	5.00
5	c	-1	-1	1	-1	-1	5.77
6	ac	1	-1	1	-1	-1	7.47
7	bc	-1	1	1	-1	-1	5.82

The SAS System

Obs	trt	A	B	C	D	E	y
8	abc	1	1	1	-1	-1	12.00
9	d	-1	-1	-1	1	-1	9.17
10	ad	1	-1	-1	1	-1	9.86
11	bd	-1	1	-1	1	-1	7.80
12	abd	1	1	-1	1	-1	3.65
13	cd	-1	-1	1	1	-1	3.23
14	acd	1	-1	1	1	-1	6.40
15	bcd	-1	1	1	1	-1	5.69
16	abcd	1	1	1	1	-1	11.61
17	e	-1	-1	-1	-1	1	8.82
18	ae	1	-1	-1	-1	1	12.43
19	be	-1	1	-1	-1	1	14.23
20	abe	1	1	-1	-1	1	17.55
21	ce	-1	-1	1	-1	1	9.20
22	ace	1	-1	1	-1	1	8.87
23	bce	-1	1	1	-1	1	8.94
24	abce	1	1	1	-1	1	25.58
25	de	-1	-1	-1	1	1	8.68
26	ade	1	-1	-1	1	1	13.06
27	bde	-1	1	-1	1	1	11.49
28	abde	1	1	-1	1	1	18.83
29	cde	-1	-1	1	1	1	6.25
30	acde	1	-1	1	1	1	11.78
31	bcde	-1	1	1	1	1	9.12
32	abcde	1	1	1	1	1	26.05

Obs	trt	A	B	C	D	E	y	AB	BC	AC	AE	BE	ABE	ABC
1	(1)	-1	-1	-1	-1	-1	8.11	1	1	1	1	1	-1	-1
2	a	1	-1	-1	-1	-1	7.93	-1	1	-1	-1	1	1	1
3	b	-1	1	-1	-1	-1	5.56	-1	-1	1	1	-1	1	1
4	ab	1	1	-1	-1	-1	5.00	1	-1	-1	-1	-1	-1	-1
5	c	-1	-1	1	-1	-1	5.77	1	-1	-1	1	1	-1	1
6	ac	1	-1	1	-1	-1	7.47	-1	-1	1	-1	1	1	-1
7	bc	-1	1	1	-1	-1	5.82	-1	1	-1	1	-1	1	-1
8	abc	1	1	1	-1	-1	12.00	1	1	1	-1	-1	-1	1

The SAS System

Obs	trt	A	B	C	D	E	y	AB	BC	AC	AE	BE	ABE	ABC
9	d	-1	-1	-1	1	-1	9.17	1	1	1	1	1	-1	-1
10	ad	1	-1	-1	1	-1	9.86	-1	1	-1	-1	1	1	1
11	bd	-1	1	-1	1	-1	7.80	-1	-1	1	1	-1	1	1
12	abd	1	1	-1	1	-1	3.65	1	-1	-1	-1	-1	-1	-1
13	cd	-1	-1	1	1	-1	3.23	1	-1	-1	1	1	-1	1
14	acd	1	-1	1	1	-1	6.40	-1	-1	1	-1	1	1	-1
15	bcd	-1	1	1	1	-1	5.69	-1	1	-1	1	-1	1	-1
16	abcd	1	1	1	1	-1	11.61	1	1	1	-1	-1	-1	1
17	e	-1	-1	-1	-1	1	8.82	1	1	1	-1	-1	1	-1
18	ae	1	-1	-1	-1	1	12.43	-1	1	-1	1	-1	-1	1
19	be	-1	1	-1	-1	1	14.23	-1	-1	1	-1	1	-1	1
20	abe	1	1	-1	-1	1	17.55	1	-1	-1	1	1	1	-1
21	ce	-1	-1	1	-1	1	9.20	1	-1	-1	-1	-1	1	1
22	ace	1	-1	1	-1	1	8.87	-1	-1	1	1	-1	-1	-1
23	bce	-1	1	1	-1	1	8.94	-1	1	-1	-1	1	-1	-1
24	abce	1	1	1	-1	1	25.58	1	1	1	1	1	1	1
25	de	-1	-1	-1	1	1	8.68	1	1	1	-1	-1	1	-1
26	ade	1	-1	-1	1	1	13.06	-1	1	-1	1	-1	-1	1
27	bde	-1	1	-1	1	1	11.49	-1	-1	1	-1	1	-1	1
28	abde	1	1	-1	1	1	18.83	1	-1	-1	1	1	1	-1
29	cde	-1	-1	1	1	1	6.25	1	-1	-1	-1	-1	1	1
30	acde	1	-1	1	1	1	11.78	-1	-1	1	1	-1	-1	-1
31	bcde	-1	1	1	1	1	9.12	-1	1	-1	-1	1	-1	-1
32	abcde	1	1	1	1	1	26.05	1	1	1	1	1	1	1

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
A	2	-1 1
B	2	-1 1
C	2	-1 1
E	2	-1 1

The SAS System

Number of Observations Read	32
Number of Observations Used	32

The GLM Procedure

Dependent Variable: y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	885.4462813	88.5446281	57.23	<.0001
Error	21	32.4886906	1.5470805		
Corrected Total	31	917.9349719			

R-Square	Coeff Var	Root MSE	y Mean
0.964607	12.21112	1.243817	10.18594

d) e)

Source	DF	Type I SS	Mean Square	F Value	Pr > F
A	1	153.9573781	153.9573781	99.51	<.0001
B	1	84.1428781	84.1428781	54.39	<.0001
E	1	286.8611281	286.8611281	185.42	<.0001
AB	1	34.1344531	34.1344531	22.06	0.0001
AC	1	53.2770031	53.2770031	34.44	<.0001
AE	1	62.3007031	62.3007031	40.27	<.0001
BC	1	49.4763781	49.4763781	31.98	<.0001
BE	1	89.4787531	89.4787531	57.84	<.0001
ABC	1	45.4819531	45.4819531	29.40	<.0001
ABE	1	26.3356531	26.3356531	17.02	0.0005

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	1	153.9573781	153.9573781	99.51	<.0001
B	1	84.1428781	84.1428781	54.39	<.0001
E	1	286.8611281	286.8611281	185.42	<.0001
AB	1	34.1344531	34.1344531	22.06	0.0001
AC	1	53.2770031	53.2770031	34.44	<.0001
AE	1	62.3007031	62.3007031	40.27	<.0001
BC	1	49.4763781	49.4763781	31.98	<.0001
BE	1	89.4787531	89.4787531	57.84	<.0001

The SAS System

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ABE	1	26.3356531	26.3356531	17.02	0.0005

The GLM Procedure

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Class	**Levels**	**Values**
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B	2	-1 1
C	2	-1 1
E	2	-1 1

Number of Observations Read	32
Number of Observations Used	32

The GLM Procedure

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AC	1	53.2770031	53.2770031	34.44	<.0001
AE	1	62.3007031	62.3007031	40.27	<.0001
BC	1	49.4763781	49.4763781	31.98	<.0001

The SAS System

Source	DF	Type I SS	Mean Square	F Value	Pr > F
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B	1	84.1428781	84.1428781	54.39	<.0001
E	1	286.8611281	286.8611281	185.42	<.0001
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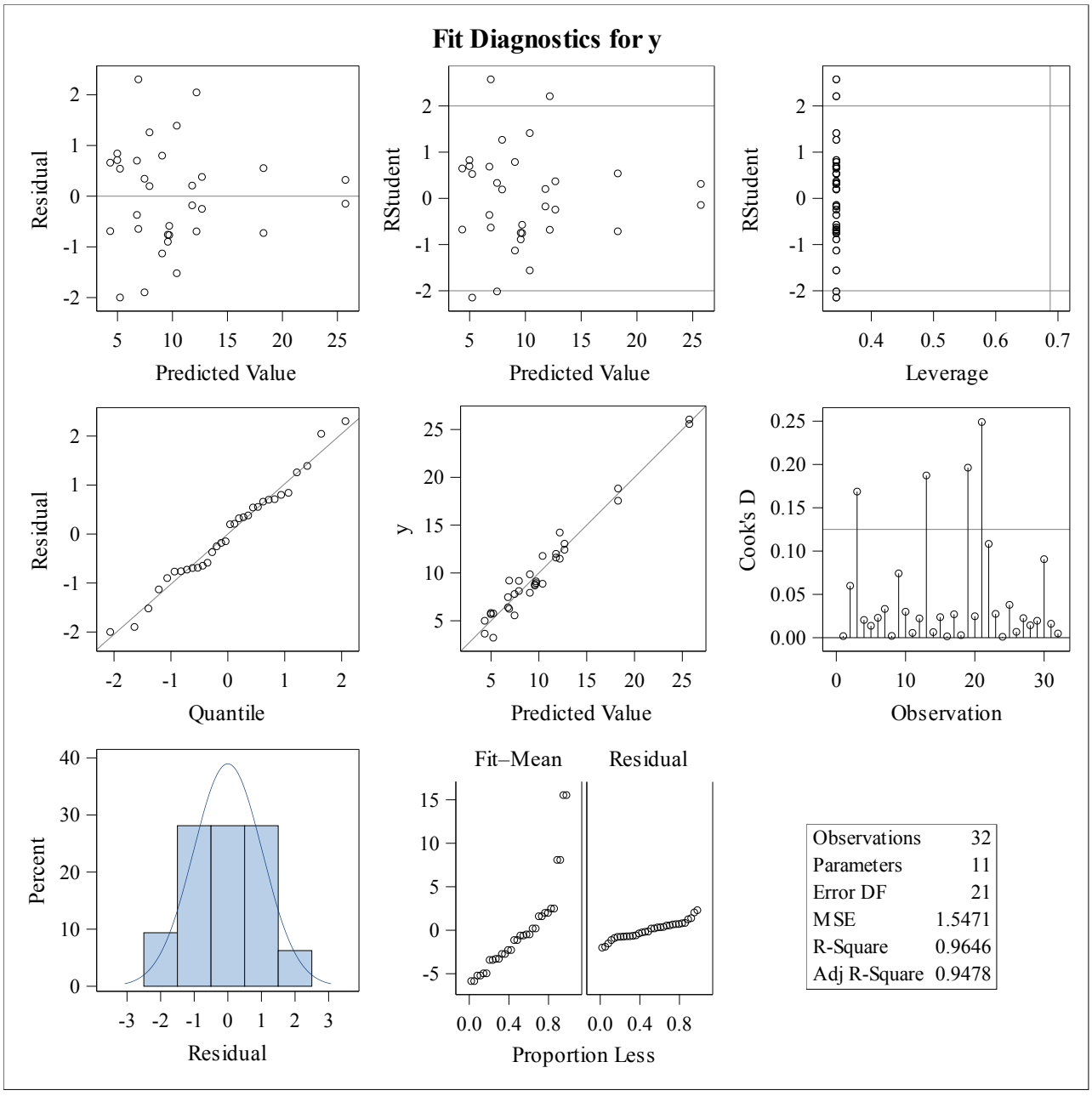
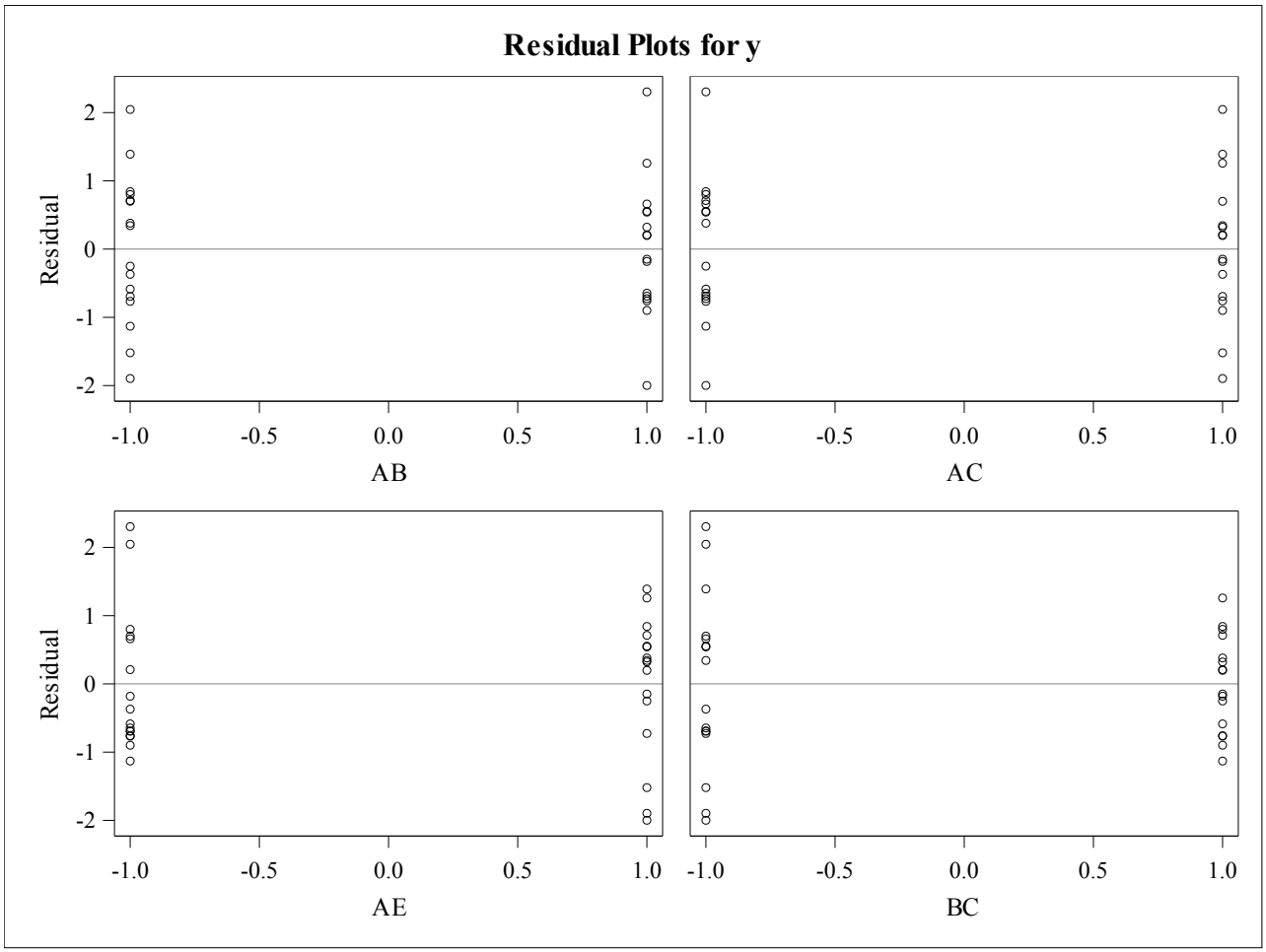
AC	1	53.2770031	53.2770031	34.44	<.0001
AE	1	62.3007031	62.3007031	40.27	<.0001
BC	1	49.4763781	49.4763781	31.98	<.0001
BE	1	89.4787531	89.4787531	57.84	<.0001
ABC	1	45.4819531	45.4819531	29.40	<.0001
ABE	1	26.3356531	26.3356531	17.02	0.0005

f).

The SAS System



The SAS System



The SAS System