Chapter21 Randomized block design

```
Temp<-gl(4,5,4*5, labels=c(22,23,24,25))
Coil<-gl(5,1,5*4, labels=c(1,2,3,4,5))
Induct<-c(1.400, 0.264, 0.478,
 1.010, 0.629, 1.400, 0.235, 0.467, 0.990, 0.620, 1.375, 0.212, 0.444,
0.968, 0.495, 1.370, 0.208, 0.440, 0.967, 0.495)
Mydata<-cbind(Temp, Coil,  Induct)
head(Mydata)

##      Temp Coil Induct
## [1,]    1    1  1.400
## [2,]    1    2  0.264
## [3,]    1    3  0.478
## [4,]    1    4  1.010
## [5,]    1    5  0.629
## [6,]    2    1  1.400

plot( Induct ~ Temp )
result1<-lm(Induct~Coil+Temp)
result1

##
## Call:
## lm(formula = Induct ~ Coil + Temp)
##
## Coefficients:
## (Intercept)         Coil2         Coil3         Coil4         Coil5
##      1.4191       -1.1565       -0.9290       -0.4025       -0.8265
##      Temp23        Temp24        Temp25
##     -0.0138       -0.0574       -0.0602

 output <- anova(result1)
 output

## Analysis of Variance Table
##
## Response: Induct
##           Df Sum Sq Mean Sq    F value     Pr(>F)
## Coil       4 3.3938 0.84846 1295.3583 1.063e-15 ***
## Temp       3 0.0140 0.00465    7.1062  0.005319 **
## Residuals 12 0.0079 0.00066
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

names(output)

## [1] "Df"       "Sum Sq"  "Mean Sq" "F value" "Pr(>F)"
```

```
 SSBL <- output$"Sum Sq"[1]
 MSBLTR <- output$"Mean Sq"[3]
a <- 4
 nb <- 5
VarCR <- (SSBL + (nb-1)*(a-1)*MSBLTR)/(a*(nb-1))
 # RE without correction
 EFF <- VarCR / MSBLTR
EFF

## [1] 324.5896

result2<-lm(Induct~Temp)

(summary(result2)$sig/summary(result1)$sig)^2

## [1] 324.5896

library(lme4)

## Loading required package: Matrix
```
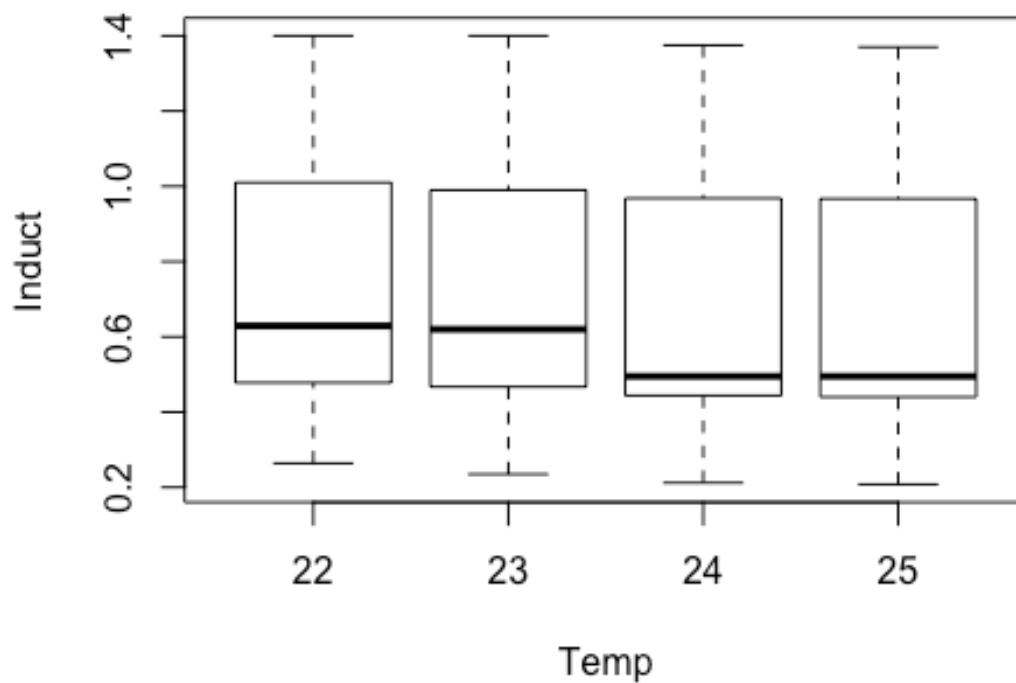


```
result<-lmer(Induct~(1|Coil)+Temp)
result
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Induct ~ (1 | Coil) + Temp
## REML criterion at convergence: -36.784
## Random effects:
##  Groups    Name         Std.Dev.
##  Coil     (Intercept) 0.46038
##  Residual              0.02559
## Number of obs: 20, groups:  Coil, 5
## Fixed Effects:
## (Intercept)        Temp23        Temp24        Temp25
##      0.7562       -0.0138       -0.0574       -0.0602
```

```
#get residuals
res <- residuals(result)
 # get fitted values
 fit <- predict(result)
 plot( res ~ fit )
```
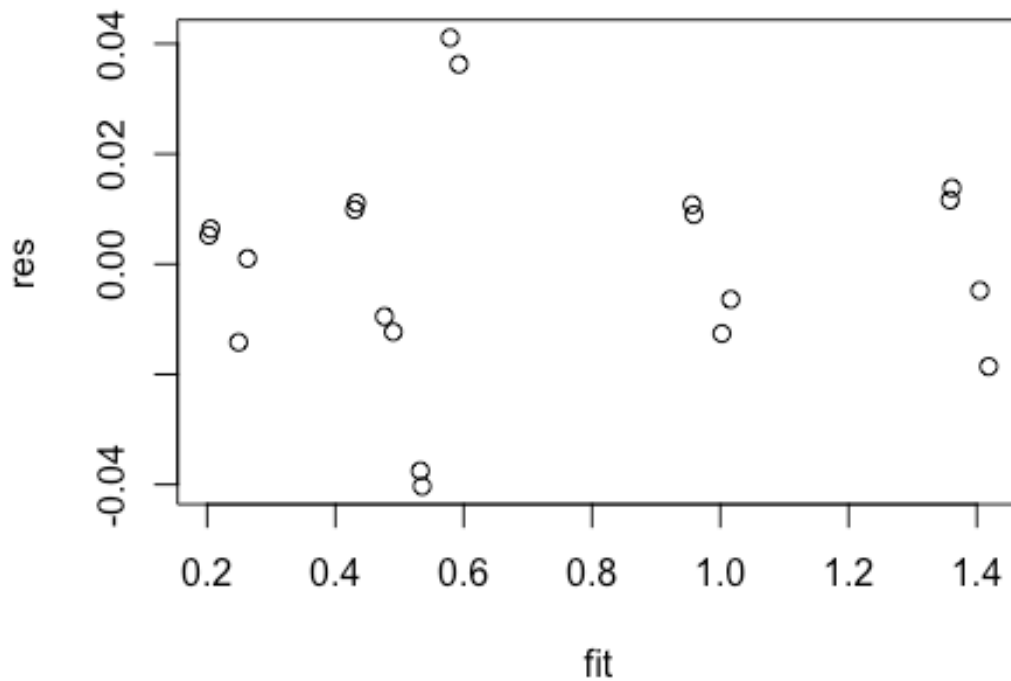


```
 qqnorm(res)
 qqline(res)
```

Normal Q-Q Plot