Problem 6.17.

R Program

```
prob6.17 <- read.table("http://www.stat.ufl.edu/~winner/sta4702/data/wichern/T6-
8.dat",
     header=F,col.names=c("x1","x2","x3","x4"))
attach(prob6.17)

n <- length(x1)
X <- cbind(x1,x2,x3,x4)
q <- ncol(X)

(xbar <- (1/n) * (t(X) %*% rep(1,n)))

I_n <- diag(n); J_n <- matrix(rep(1,n^2),n,n)

(S <- (1/(n-1)) * (t(X) %*% (I_n - (1/n)*J_n) %*% X))

C_A <- matrix(c(1,-1,0,0,1,0,-1,0,1,0,0,-1),byrow=T,ncol=4)

(Tsq <- n * (t(C_A%*%xbar) %*% solve(C_A%*%S%*%t(C_A)) %*% (C_A%*%xbar)))

(Tsq_CV <- ((n-1)*(q-1)/(n-q+1)) * qf(.95,q-1,n-q+1))

### Number format effect:  C1' = [+1,+1,-1,-1]
### Parity Type Effect:    C2' = [-1,+1,-1,+1]
### Interaction Effect:    C3' = [-1,+1,+1,-1]

crit_ci <- sqrt(Tsq_CV)
CB1 <- c(1,1,-1,-1)
CB2 <- c(-1,1,-1,1)
CB3 <- c(-1,1,1,-1)

c_format_mean <- t(CB1) %*% xbar
c_format_sd <- sqrt((1/n) * (t(CB1) %*% S %*% CB1))
c_parity_mean <- t(CB2) %*% xbar
c_parity_sd <- sqrt((1/n) * (t(CB2) %*% S %*% CB2))
c_inter_mean <- t(CB3) %*% xbar
c_inter_sd <- sqrt((1/n) * (t(CB3) %*% S %*% CB3))

c_format_LB <- c_format_mean - crit_ci * c_format_sd
c_format_UB <- c_format_mean + crit_ci * c_format_sd

c_parity_LB <- c_parity_mean - crit_ci * c_parity_sd
c_parity_UB <- c_parity_mean + crit_ci * c_parity_sd

c_inter_LB <- c_inter_mean - crit_ci * c_inter_sd
c_inter_UB <- c_inter_mean + crit_ci * c_inter_sd

round(cbind(c_format_mean, c_format_LB, c_format_UB))
round(cbind(c_parity_mean, c_parity_LB, c_parity_UB))
round(cbind(c_inter_mean, c_inter_LB, c_inter_UB))
```

Continued

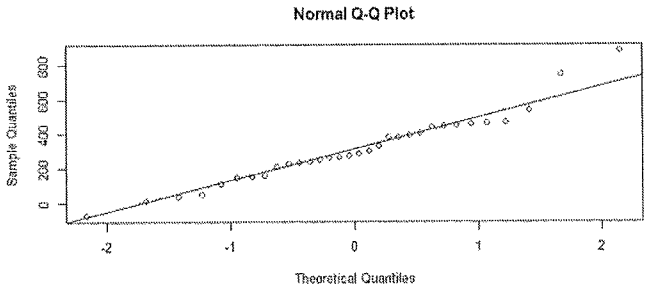
```
### Create difference scores for subjects

diffsc1 <- x1 + x2 - x3 - x4
diffsc2 <- x2 + x4 - x1 - x3
diffsc3 <- x2 + x3 - x1 - x4

par(mfrow=c(2,2))
qqnorm(diffsc1); qqline(diffsc1)
qqnorm(diffsc2); qqline(diffsc2)
qqnorm(diffsc3); qqline(diffsc3)

par(mfrow=c(2,2))
plot(diffsc1,diffsc2)
plot(diffsc1,diffsc3)
plot(diffsc2,diffsc3)

X_diff <- cbind(diffsc1,diffsc2,diffsc3)
(xbar_diff <- (1/n) * (t(X_diff) %*% rep(1,n)))
(S_diff <- (1/(n-1)) * (t(X_diff)  %*% (I_n - (1/n)*J_n) %*% X_diff))

xbar1_diff <- rep(xbar_diff[1,],n)
xbar2_diff <- rep(xbar_diff[2,],n)
xbar3_diff <- rep(xbar_diff[3,],n)
xbar_diff_mat <- cbind(xbar1_diff,xbar2_diff,xbar3_diff)

X2_diff <- (X_diff - xbar_diff_mat) %*% solve(S_diff) %*%
          t(X_diff - xbar_diff_mat)
X2_diff <- diag(X2_diff)

X2_diff_s <- sort(X2_diff)
j <- 1:n
qcp <- qchisq((j-0.5)/n,3)
par(mfrow=c(1,1))

plot(qcp, X2_diff_s)
```

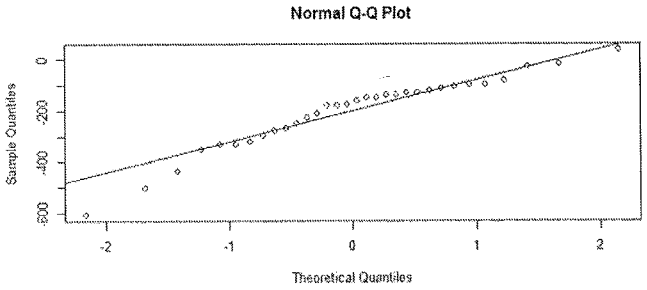
Text Output

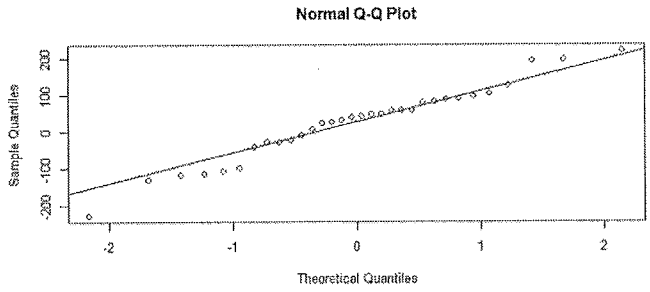
```
> (xbar <- (1/n) * (t(X) %*% rep(1,n)))
       [,1]
x1 967.5625
x2 875.6094
x3 825.3125
x4 710.9375
>
> (S <- (1/(n-1)) * (t(X) %*% (I_n - (1/n)*J_n) %*% X))
          x1       x2       x3       x4
x1 36178.35 25936.73 18447.57 15909.24
x2 25936.73 22597.75 14261.73 14115.93
x3 18447.57 14261.73 18487.82 11799.73
x4 15909.24 14115.93 11799.73 13001.40
>
> C_A <- matrix(c(1,-1,0,0,1,0,-1,0,1,0,0,-1),byrow=T,ncol=4)
>
> (Tsq <- n * (t(C_A%*%xbar) %*% solve(C_A%*%S%*%t(C_A)) %*% (C_A%*%xbar)))
         [,1]
[1,] 153.7275
>
> (Tsq_CV <- ((n-1)*(q-1)/(n-q+1)) * qf(.95,q-1,n-q+1))
[1] 9.40913
>
```

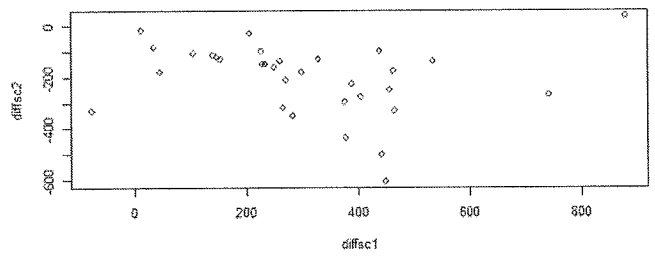
```
> round(c(c_format_mean, c_format_LB, c_format_UB))
[1] 307 198 416
> round(c(c_parity_mean, c_parity_LB, c_parity_UB))
[1] -206 -282 -130
> round(c(c_inter_mean, c_inter_LB, c_inter_UB))
[1]  22 -32  77
```

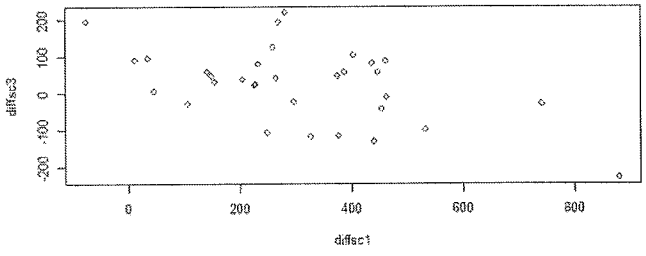
Graphs

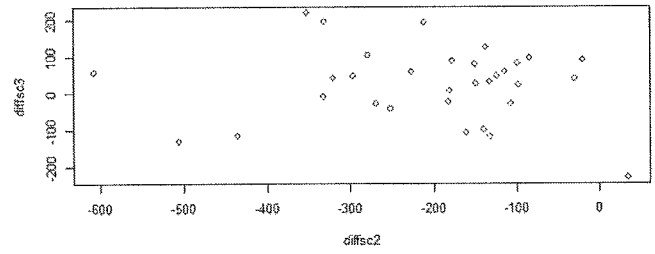


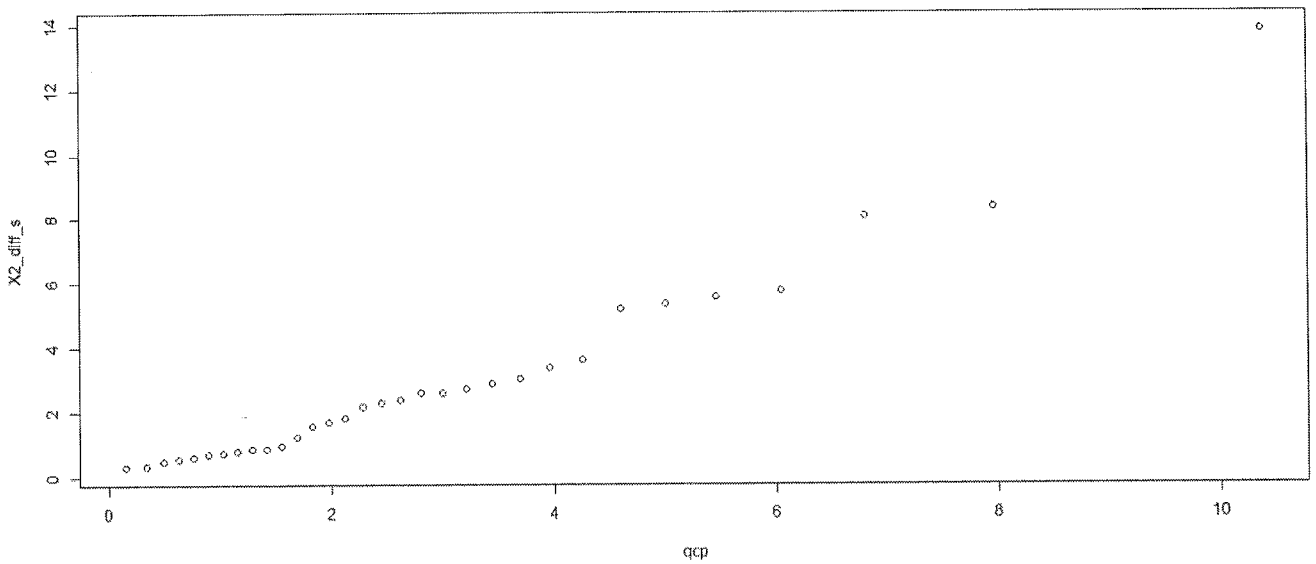











X2_diff_s
0
2
4
6
8
10
12
14
qcp
0
2
4
6
8
10

Problem 6.18

R Program

```
prob6.18 <- read.table("http://www.stat.ufl.edu/~winner/sta4702/data/wichern/T6-
9.dat",
     header=F,col.names=c("x1","x2","x3","gender"))
attach(prob6.18)

prob6.18

qqnorm(x1); qqline(x1)
qqnorm(x2); qqline(x2)
qqnorm(x3); qqline(x3)

x1m <- x1[gender == "male"]
x2m <- x2[gender == "male"]
x3m <- x3[gender == "male"]
x1f <- x1[gender == "female"]
x2f <- x2[gender == "female"]
x3f <- x3[gender == "female"]
n_m <- length(x1m); n_f <- length(x1f)

X_m <- cbind(log(x1m),log(x2m),log(x3m))
X_f <- cbind(log(x1f),log(x2f),log(x3f))
p <- ncol(X_m)

I_nm <- diag(n_m); I_nf <- diag(n_f)
J_nm <- matrix(rep(1,n_m^2),n_m,n_m);  J_nf <- matrix(rep(1,n_f^2),n_f,n_f)

xbar_m <- (1/n_m) * (t(X_m) %*% rep(1,n_m))
xbar_f <- (1/n_f) * (t(X_f) %*% rep(1,n_f))

S_m <- (1/(n_m-1)) * (t(X_m) %*% (I_nm - (1/n_m)*J_nm) %*% X_m)
S_f <- (1/(n_f-1)) * (t(X_f) %*% (I_nf - (1/n_f)*J_nf) %*% X_f)
S_p <- ((n_m-1) * S_m + (n_f-1) * S_f) / (n_m + n_f -2)

(Tsq <- t(xbar_m - xbar_f) %*% solve(((1/n_m) + (1/n_f)) * S_p) %*% (xbar_m -
xbar_f))
(Tsq_CV <- (((n_m+n_f-2)*p)/(n_m+n_f-p-1)) * qf(.95,p,n_m+n_f-2-1))

### Linear combination of mean components most responsible for rejecting H0

(ahat <- solve(S_p) %*% (xbar_m - xbar_f))

### Confidence Intervals

S_pd <- diag(S_p)

xb_d <- xbar_m - xbar_f
xb_d_LO_sim <- xb_d - sqrt(Tsq_CV) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_HI_sim <- xb_d + sqrt(Tsq_CV) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_LO_bon <- xb_d - qt(1-.05/(2*p),n_m+n_f-2) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_HI_bon <- xb_d + qt(1-.05/(2*p),n_m+n_f-2) * sqrt(S_pd*(1/n_m + 1/n_f))

CI.out <- cbind(xb_d,xb_d_LO_sim,xb_d_HI_sim,xb_d_LO_bon,xb_d_HI_bon)
colnames(CI.out) <- c("Xbar M-F","Lo sim", "Hi sim", "Lo bon", "Hi bon")
CI.out
```

R Text Output

```
> (xbar_m <- (1/n_m) * (t(X_m) %*% rep(1,n_m)))
          [,1]
[1,] 4.725444
[2,] 4.477574
[3,] 3.703186
> (xbar_f <- (1/n_f) * (t(X_f) %*% rep(1,n_f)))
          [,1]
[1,] 4.900659
[2,] 4.622909
[3,] 3.940286
>
> (S_m <- (1/(n_m-1)) * (t(X_m) %*% (I_nm - (1/n_m)*J_nm) %*% X_m))
             [,1]        [,2]        [,3]
[1,] 0.011072004 0.008019142 0.008159648
[2,] 0.008019142 0.006416726 0.006005271
[3,] 0.008159648 0.006005271 0.006772758
> (S_f <- (1/(n_f-1)) * (t(X_f) %*% (I_nf - (1/n_f)*J_nf) %*% X_f))
             [,1]       [,2]       [,3]
[1,] 0.02640563 0.02011195 0.02491758
[2,] 0.02011195 0.01619045 0.01942430
[3,] 0.02491758 0.01942430 0.02493980
> (S_p <- ((n_m-1) * S_m + (n_f-1) * S_f) / (n_m + n_f -2))
             [,1]       [,2]       [,3]
[1,] 0.01873882 0.01406555 0.01653862
[2,] 0.01406555 0.01130359 0.01271478
[3,] 0.01653862 0.01271478 0.01585628
>
> (Tsq <- t(xbar_m - xbar_f) %*% solve(((1/n_m) + (1/n_f)) * S_p) %*% (xbar_m - xbar_f))
       [,1]
[1,] 85.052
> (Tsq_CV <- (((n_m+n_f-2)*p)/(n_m+n_f-p-1)) * qf(.95,p,n_m+n_f-2-1))
[1] 8.818023
>
> ### Linear combination of mean components most responsible for rejecting H0
>
> (ahat <- solve(S_p) %*% (xbar_m - xbar_f))
             [,1]
[1,]  43.726770
[2,]   8.710687
[3,] -67.546415
>
> ### Confidence Intervals
>
> CI.out
       Xbar M-F     Lo sim      Hi sim     Lo bon      Hi bon
[1,] -0.1752157 -0.2925611 -0.05787029 -0.2734025 -0.07702893
[2,] -0.1453352 -0.2364739 -0.05419640 -0.2215940 -0.06907636
[3,] -0.2371000 -0.3450432 -0.12915668 -0.3274197 -0.14678026
>
```

Problem 6.21

n1	n2	p
20	20	4
xbar1	xbar2	xbardiff
2.287	2.404	-0.117
12.6	7.155	5.445
0.347	0.524	-0.177
14.83	12.84	1.99

S1				S2			
0.459	0.254	-0.026	-0.244	0.944	-0.089	0.002	-0.719
0.254	27.465	-0.589	-0.267	-0.089	16.432	-0.4	19.044
-0.026	-0.589	0.03	0.102	0.002	-0.4	0.024	-0.094
-0.244	-0.267	0.102	6.854	-0.719	19.044	-0.094	61.854

Sp				(1/n1+1/n2)Sp			
0.7015	0.0825	-0.012	-0.4815	0.07015	0.00825	-0.0012	-0.04815
0.0825	21.9485	-0.4945	9.3885	0.00825	2.19485	-0.04945	0.93885
-0.012	-0.4945	0.027	0.004	-0.0012	-0.04945	0.0027	0.0004
-0.4815	9.3885	0.004	34.354	-0.04815	0.93885	0.0004	3.4354

inv((1/n1+1/n2)Sp)			
14.504	0.007263	6.549531	0.200538
0.007263	0.972215	17.84882	-0.26767
6.549531	17.84882	700.9003	-4.86766
0.200538	-0.26767	-4.86766	0.367615

Tsq	multEqV	F_EqV	CritVEqV
15.82996	4.342857	2.641465	11.47151
ahat	simdiff	Bondiff	
-0.24176	0.897065	0.694512	
0.160096	5.017792	3.884795	
-3.73255	0.175992	0.136253	
0.01122	6.277676	4.860202	

(1/n1)S1inv((1/n1+1/n2)Sp)				(1/n2)S2inv((1/n1+1/n2)Sp)			
0.321998	-0.00742	-0.47479	0.003046	0.856606	0.00938	0.599866	-0.00385
-0.00139	0.813112	4.017546	-0.22659	0.001751	0.236119	-5.07588	0.286275
-0.00822	-0.00323	0.492363	0.002196	0.010388	0.004085	0.641362	-0.00277
-0.07492	-0.01377	1.588257	0.102283	0.094654	0.017396	-2.00665	1.134199

((1/n1)S1inv((1/n1+1/n2)Sp))^2				((1/n2)S2inv((1/n1+1/n2)Sp))^2			
0.107369	-0.00693	-0.41164	0.001932	0.739658	0.012633	0.858693	-0.00664
-0.01763	0.651293	4.885589	-0.1986	-0.02372	0.040015	-5.02739	0.406361
-0.00686	-0.00419	0.236823	0.002013	0.015305	0.003633	0.402409	-0.0038
-0.04483	-0.01718	0.924704	0.016841	0.167624	0.01653	-3.59445	1.29659

trace11	trace12	trace12^2	den1	trace21	trace22	trace22^2	den2
1.012325	1.729757	2.992059	0.200219	2.478672	2.868287	8.227068	0.411353

df
32.70258

multUneqV	F_UneqV	CritVUneqV
4.40400537	2.668437	11.75181

Problem 6.22

R Program

```
prob6.22 <- read.table("http://www.stat.ufl.edu/~winner/sta4702/data/wichern/T6-12.dat",
     header=F,col.names=c("x1","x2","x3","x4","gender"))
attach(prob6.22)

x1m <- x1[gender == "male"]
x2m <- x2[gender == "male"]
x3m <- x3[gender == "male"]
x4m <- x4[gender == "male"]
x1f <- x1[gender == "female"]
x2f <- x2[gender == "female"]
x3f <- x3[gender == "female"]
x4f <- x4[gender == "female"]
n_m <- length(x1m); n_f <- length(x1f)

X_m <- cbind(x1m,x2m,x3m,x4m)
X_f <- cbind(x1f,x2f,x3f,x4f)
p <- ncol(X_m)

I_nm <- diag(n_m); I_nf <- diag(n_f)
J_nm <- matrix(rep(1,n_m^2),n_m,n_m);  J_nf <- matrix(rep(1,n_f^2),n_f,n_f)

(xbar_m <- (1/n_m) * (t(X_m) %*% rep(1,n_m)))
(xbar_f <- (1/n_f) * (t(X_f) %*% rep(1,n_f)))

(S_m <- (1/(n_m-1)) * (t(X_m) %*% (I_nm - (1/n_m)*J_nm) %*% X_m))
(S_f <- (1/(n_f-1)) * (t(X_f) %*% (I_nf - (1/n_f)*J_nf) %*% X_f))
(S_p <- ((n_m-1) * S_m + (n_f-1) * S_f) / (n_m + n_f -2))

(Tsq <- t(xbar_m - xbar_f) %*% solve(((1/n_m) + (1/n_f)) * S_p) %*% (xbar_m - xbar_f))
(Tsq_CV <- (((n_m+n_f-2)*p)/(n_m+n_f-p-1)) * qf(.95,p,n_m+n_f-2-1))

### Linear combination of mean components most responsible for rejecting H0

(ahat <- solve(S_p) %*% (xbar_m - xbar_f))

### Confidence Intervals

S_pd <- diag(S_p)

xb_d <- xbar_m - xbar_f
xb_d_LO_sim <- xb_d - sqrt(Tsq_CV) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_HI_sim <- xb_d + sqrt(Tsq_CV) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_LO_bon <- xb_d - qt(1-.05/(2*p),n_m+n_f-2) * sqrt(S_pd*(1/n_m + 1/n_f))
xb_d_HI_bon <- xb_d + qt(1-.05/(2*p),n_m+n_f-2) * sqrt(S_pd*(1/n_m + 1/n_f))

CI.out <- cbind(xb_d,xb_d_LO_sim,xb_d_HI_sim,xb_d_LO_bon,xb_d_HI_bon)
colnames(CI.out) <- c("Xbar M-F","Lo sim", "Hi sim", "Lo bon", "Hi bon")
CI.out
```

R Output

```
> (xbar_m <- (1/n_m) * (t(X_m) %*% rep(1,n_m)))
       [,1]
x1m  0.3972
x2m  5.3296
x3m  3.6876
x4m 49.4204
> (xbar_f <- (1/n_f) * (t(X_f) %*% rep(1,n_f)))
       [,1]
x1f  0.3136
x2f  5.1788
x3f  2.3152
x4f 38.1548
>
> (S_m <- (1/(n_m-1)) * (t(X_m) %*% (I_nm - (1/n_m)*J_nm) %*% X_m))
           x1m       x2m        x3m        x4m
x1m 0.00712100 0.0700030 0.03144717  0.1505803
x2m 0.07000300 1.1441790 0.14767817  3.4309085
x3m 0.03144717 0.1476782 0.45587733  3.3081218
x4m 0.15058033 3.4309085 3.30812183 55.2521457
> (S_f <- (1/(n_f-1)) * (t(X_f) %*% (I_nf - (1/n_f)*J_nf) %*% X_f))
            x1f         x2f         x3f       x4f
x1f 0.009732333  0.15408783  0.00416800  0.029757
x2f 0.154087833  2.78066100 -0.03944767  1.280698
x3f 0.004168000 -0.03944767  0.12050933  1.098149
x4f 0.029757000  1.28069767  1.09814900 23.260826
> (S_p <- ((n_m-1) * S_m + (n_f-1) * S_f) / (n_m + n_f -2))
            x1m         x2m         x3m         x4m
x1m 0.008426667 0.11204542 0.01780758  0.09016867
x2m 0.112045417 1.96242000 0.05411525  2.35580308
x3m 0.017807583 0.05411525 0.28819333  2.20313542
x4m 0.090168667 2.35580308 2.20313542 39.25648583
>
> (Tsq <- t(xbar_m - xbar_f) %*% solve(((1/n_m) + (1/n_f)) * S_p) %*% (xbar_m -
xbar_f))
         [,1]
[1,] 96.37322
> (Tsq_CV <- (((n_m+n_f-2)*p)/(n_m+n_f-p-1)) * qf(.95,p,n_m+n_f-2-1))
[1] 10.96337
>
> ### Linear combination of mean components most responsible for rejecting H0
>
> (ahat <- solve(S_p) %*% (xbar_m - xbar_f))
          [,1]
x1m 99.3989780
x2m -6.3759988
x3m -6.2281408
x4m  0.7908238

> CI.out
    Xbar M-F       Lo sim     Hi sim      Lo bon     Hi bon
x1m   0.0836 -0.002369609  0.1695696  0.01621484  0.1509852
x2m   0.1508 -1.161137132  1.4627371 -0.87752962  1.1791296
x3m   1.3724  0.869641978  1.8751580  0.97832550  1.7664745
x4m  11.2656  5.397834446 17.1333656  6.66629645 15.8649035
```

Problem 6.24

R Program

```
prob6.24 <- read.table("http://www.stat.ufl.edu/~winner/sta4702/data/wichern/T6-
13.dat",
     header=F,col.names=c("x1","x2","x3","x4","time.prd"))
attach(prob6.24)

x11 <- x1[time.prd==1]
x12 <- x1[time.prd==2]
x13 <- x1[time.prd==3]
x21 <- x2[time.prd==1]
x22 <- x2[time.prd==2]
x23 <- x2[time.prd==3]
x31 <- x3[time.prd==1]
x32 <- x3[time.prd==2]
x33 <- x3[time.prd==3]
x41 <- x4[time.prd==1]
x42 <- x4[time.prd==2]
x43 <- x4[time.prd==3]
n1 <- length(x11)
n2 <- length(x12)
n3 <- length(x13)
n <- length(x1)

X1 <- cbind(x11,x21,x31,x41)
X2 <- cbind(x12,x22,x32,x42)
X3 <- cbind(x13,x23,x33,x43)
X <-  cbind(x1,x2,x3,x4)
p <- ncol(X)
g <- 3

(xbar1 <- (1/n1) * (t(X1) %*% rep(1,n1)))
(xbar2 <- (1/n2) * (t(X2) %*% rep(1,n2)))
(xbar3 <- (1/n3) * (t(X3) %*% rep(1,n3)))
(xbar <- (1/n) * (t(X) %*% rep(1,n)))

I_n1 <- diag(n1);   J_n1 <- matrix(rep(1,n1^2),n1,n1)
I_n2 <- diag(n2);   J_n2 <- matrix(rep(1,n2^2),n2,n2)
I_n3 <- diag(n3);   J_n3 <- matrix(rep(1,n3^2),n3,n3)

B1 = n1 * ((xbar1 - xbar) %*% t(xbar1 - xbar))
B2 = n2 * ((xbar2 - xbar) %*% t(xbar2 - xbar))
B3 = n3 * ((xbar3 - xbar) %*% t(xbar3 - xbar))

W1 = t(X1) %*% (I_n1 - (1/n1) * J_n1) %*% X1
W2 = t(X2) %*% (I_n2 - (1/n2) * J_n2) %*% X2
W3 = t(X3) %*% (I_n3 - (1/n3) * J_n3) %*% X3

B = B1 + B2 + B3
W = W1 + W2 + W3
T = B + W
```

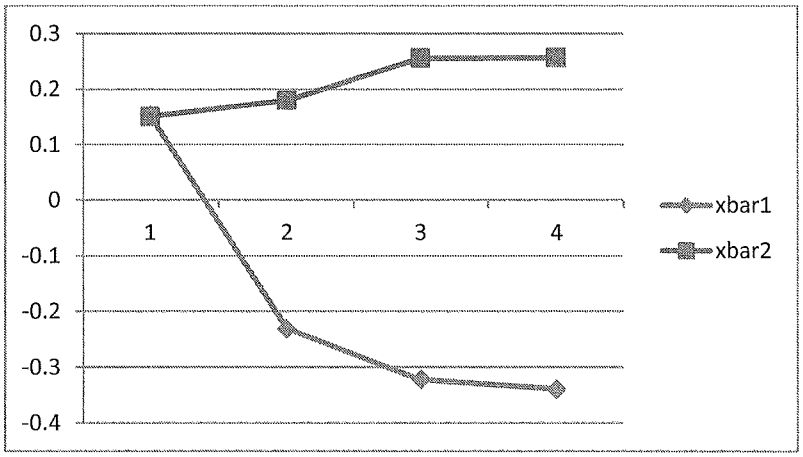
Continued

```
(Lstar <- det(W) / det(T))
(TestStat <- ((n-p-2)/p)*((1-sqrt(Lstar))/sqrt(Lstar)))
(CritVal <- qf(.95,2*p,2*(n-p-2)))
(Pvalue <- 1-pf(TestStat,2*p,2*(n-p-2)))



(B.TS <- -(n-1-(p+g)/2) * log(Lstar))
(B.CV <- qchisq(.95,p*(g-1)))

### Simultaneous Bonferroni CIs
### All n_i=30

Bon.t <- qt(1-.05/(2*p*g*(g-1)),n1-1)
sediff.1 <- sqrt(2*W[1,1]/((n-g)*n1))
sediff.2 <- sqrt(2*W[2,2]/((n-g)*n1))
sediff.3 <- sqrt(2*W[3,3]/((n-g)*n1))
sediff.4 <- sqrt(2*W[4,4]/((n-g)*n1))
crit.diff1 <- Bon.t * sediff.1
crit.diff2 <- Bon.t * sediff.2
crit.diff3 <- Bon.t * sediff.3
crit.diff4 <- Bon.t * sediff.4

diff12.1 <- xbar1[1]-xbar2[1]; diff13.1 <- xbar1[1]-xbar3[1]; diff23.1 <- xbar2[1]-xbar3[1]
diff12.2 <- xbar1[2]-xbar2[2]; diff13.2 <- xbar1[2]-xbar3[2]; diff23.2 <- xbar2[2]-xbar3[2]
diff12.3 <- xbar1[3]-xbar2[3]; diff13.3 <- xbar1[3]-xbar3[3]; diff23.3 <- xbar2[3]-xbar3[3]

round(cbind(diff12.1,diff13.1,diff23.1,crit.diff1),3)
round(cbind(diff12.2,diff13.2,diff23.2,crit.diff2),3)
round(cbind(diff12.3,diff13.3,diff23.3,crit.diff3),3)


####

prob624.manova <- manova(cbind(x1,x2,x3,x4) ~ factor(time.prd))
summary(prob624.manova, test="Wilks")
```

R Output

```
> (xbar1 <- (1/n1) * (t(X1) %*% rep(1,n1)))
         [,1]
x11 131.36667
x21 133.60000
x31  99.16667
x41  50.53333
> (xbar2 <- (1/n2) * (t(X2) %*% rep(1,n2)))
         [,1]
x12 132.36667
x22 132.70000
x32  99.06667
x42  50.23333
> (xbar3 <- (1/n3) * (t(X3) %*% rep(1,n3)))
         [,1]
x13 134.46667
x23 133.80000
x33  96.03333
x43  50.56667
> (xbar <- (1/n) * (t(X) %*% rep(1,n)))
        [,1]
x1 132.73333
x2 133.36667
x3  98.08889
x4  50.44444

> (Lstar <- det(W) / det(T))
[1] 0.8301027
> (TestStat <- ((n-p-2)/p)*((1-sqrt(Lstar))/sqrt(Lstar)))
[1] 2.049069
> (CritVal <- qf(.95,2*p,2*(n-p-2)))
[1] 1.993884
> (Pvalue <- 1-pf(TestStat,2*p,2*(n-p-2)))
[1] 0.04358254
>
> (B.TS <- -(n-1-(p+g)/2) * log(Lstar))
[1] 15.9206
> (B.CV <- qchisq(.95,p*(g-1)))
[1] 15.50731

> round(cbind(diff12.1,diff13.1,diff23.1,crit.diff1),3)
     diff12.1 diff13.1 diff23.1 crit.diff1
[1,]       -1     -3.1     -2.1      3.954
> round(cbind(diff12.2,diff13.2,diff23.2,crit.diff2),3)
     diff12.2 diff13.2 diff23.2 crit.diff2
[1,]      0.9     -0.2     -1.1      4.105
> round(cbind(diff12.3,diff13.3,diff23.3,crit.diff3),3)
     diff12.3 diff13.3 diff23.3 crit.diff3
[1,]      0.1    3.133    3.033      4.342

> summary(prob624.manova, test="Wilks")
                Df  Wilks approx F num Df den Df  Pr(>F)
factor(time.prd)  2 0.8301   2.0491      8    168 0.04358 *
Residuals        87
```

Problem 6.26.



n1	n2	p					
28	58	4					
xbar1	xbar2	xb1-xb2		Spooled			
0.153	0.151	0.002		0.804	0.355	0.228	0.232
-0.231	0.18	-0.411		0.355	0.722	0.233	0.199
-0.322	0.256	-0.578		0.228	0.233	0.592	0.239
-0.339	0.257	-0.596		0.232	0.199	0.239	0.479
C					C(xb1-xb2)		
-1	1	0	0		-0.413		
0	-1	1	0		-0.167		
0	0	-1	1		-0.018		
(1/n1+1/n2)CSpC'				INV((1/n1+1/n2)CSpC')			
0.043212	-0.01917	-0.00201		31.61365	17.8747	11.6414	
-0.01917	0.044906	-0.01689		17.8747	38.02468	21.60053	
-0.00201	-0.01689	0.031403		11.6414	21.60053	44.21022	

Test for Parallel Profiles:

n1+n2-2	p-1	n1+n2-p	T^2	critmult	F(p-1,N-p)	T^2CV	T^2/cm	T^2PV
84	3	82	9.235721	3.073171	2.715937	8.346537	3.005274	0.035028

Reject H_0: Parallel Profiles. No need for tests of Coincident or Level profiles.

Problem 6.29 Paired Differences (D-ND), p=3, n=25

DRAD	NDRAD	DHUM	NDHUM	DULNA	NDULNA	DiffRAD	DiffHUM	DiffULNA
1.103	1.052	2.139	2.238	0.873	0.872	0.051	-0.099	0.001
0.842	0.859	1.873	1.741	0.59	0.744	-0.017	0.132	-0.154
0.925	0.873	1.887	1.809	0.767	0.713	0.052	0.078	0.054
0.857	0.744	1.739	1.547	0.706	0.674	0.113	0.192	0.032
0.795	0.809	1.734	1.715	0.549	0.654	-0.014	0.019	-0.105
0.787	0.779	1.509	1.474	0.782	0.571	0.008	0.035	0.211
0.933	0.88	1.695	1.656	0.737	0.803	0.053	0.039	-0.066
0.799	0.851	1.74	1.777	0.618	0.682	-0.052	-0.037	-0.064
0.945	0.876	1.811	1.759	0.853	0.777	0.069	0.052	0.076
0.921	0.906	1.954	2.009	0.823	0.765	0.015	-0.055	0.058
0.792	0.825	1.624	1.657	0.686	0.668	-0.033	-0.033	0.018
0.815	0.751	2.204	1.846	0.678	0.546	0.064	0.358	0.132
0.755	0.724	1.508	1.458	0.662	0.595	0.031	0.05	0.067
0.88	0.866	1.786	1.811	0.81	0.819	0.014	-0.025	-0.009
0.9	0.838	1.902	1.606	0.723	0.677	0.062	0.296	0.046
0.764	0.757	1.743	1.794	0.586	0.541	0.007	-0.051	0.045
0.733	0.748	1.863	1.869	0.672	0.752	-0.015	-0.006	-0.08
0.932	0.898	2.028	2.032	0.836	0.805	0.034	-0.004	0.031
0.856	0.786	1.39	1.324	0.578	0.61	0.07	0.066	-0.032
0.89	0.95	2.187	2.087	0.758	0.718	-0.06	0.1	0.04
0.688	0.532	1.65	1.378	0.533	0.482	0.156	0.272	0.051
0.94	0.85	2.334	2.225	0.757	0.731	0.09	0.109	0.026
0.493	0.616	1.037	1.268	0.546	0.615	-0.123	-0.231	-0.069
0.835	0.752	1.509	1.422	0.618	0.664	0.083	0.087	-0.046
0.915	0.936	1.971	1.869	0.869	0.868	-0.021	0.102	0.001

dbar		S_d		
0.02548		0.003663	0.004829	0.001542
0.05784		0.004829	0.016289	0.003048
0.01056		0.001542	0.003048	0.006025
n	p			
25	3			

Test of $\delta = 0$

Tsquare	n-1	p	n-p	CVMult	F(p,n-p,.05	TsqCV	Tsq/Mult	TsqPVal
5.945972	24	3	22	3.272727	3.049125	9.978955	1.816825	0.173557

Confidence Intervals

Sediff	CVSim	CVBon	SimMSD	BonMSD	SimLB	SimUB	BonLB	BonUB
0.012104	3.158948	2.573641	0.038236	0.031151	-0.012756	0.063716	-0.005671	0.056631
0.025526	3.158948	2.573641	0.080635	0.065695	-0.022795	0.138475	-0.007855	0.123535
0.015525	3.158948	2.573641	0.049041	0.039955	-0.038481	0.059601	-0.029395	0.050515

Problem 6.31

R Program and Output

```
prob6.31 <- read.table("http://www.stat.ufl.edu/~winner/sta4702/data/wichern/T6-17.dat",
     header=F,col.names=c("pn.loc","pn.var","pn.x1","pn.x2","pn.x3"))
attach(prob6.31)

pn.loc <- factor(pn.loc)
pn.var <- factor(pn.var)

prob631.manova <- manova(cbind(pn.x1,pn.x2,pn.x3) ~ pn.loc*pn.var)
summary(prob631.manova, test="Wilks")


> summary(prob631.manova, test="Wilks")
             Df    Wilks approx F num Df den Df   Pr(>F)
pn.loc        1 0.106516  11.1843      3      4 0.020502 *
pn.var        2 0.012444  10.6191      6      8 0.001928 **
pn.loc:pn.var 2 0.074300   3.5582      6      8 0.050794 .
Residuals     6
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
>
```