“Speech Data”

```
speech<-read.table("cochlear09.dt")
covariate<-rbind(t(matrix(rep(c(1,0),20), nrow=2)),
t( matrix(rep(c(0,1),21), nrow=2)))
```

Theorem 5.8(a)

```
> ## REMLE: AD(3)
> a<-REMLE.phi.delta(speech[ ,2:5], covariate, 3, REMLE=TRUE)
> round(a,2)
       [,1]   [,2]  [,3]  [,4]
[1,] 403.74   0.00  0.00  0.00
[2,]   1.03 161.40  0.00  0.00
[3,]  -0.21   1.02 99.35  0.00
[4,]  -0.25   0.30  0.84 51.61

> a<-REMLE.phi.delta(speech[ ,2:5], covariate ,1, REMLE=TRUE)
> round(a,2)
       [,1]   [,2]   [,3]  [,4]
[1,] 403.74   0.00   0.00  0.00
[2,]   1.03 161.40   0.00  0.00
[3,]   0.00   0.87 103.52  0.00
[4,]   0.00   0.00   0.94 55.48
```

Theorem 5.8(b): Table5.5 (a) (b)

```
> ## Table 5.5(a)
> ## REMLE AD(3)
> a<-cov.cor(REMLE.cov(speech[ ,2:5], covariate ,3,  REMLE=TRUE))
> a
            [,1]        [,2]        [,3]        [,4]
[1,] 403.7433797   0.8530278   0.7177508   0.6413628
[2,]   0.8530278 592.6365471   0.8998702   0.8672945
[3,]   0.7177508   0.8998702 548.5730517   0.9474153
[4,]   0.6413628   0.8672945   0.9474153 575.2053990
> round(a,2)
       [,1]   [,2]   [,3]   [,4]
[1,] 403.74   0.85   0.72   0.64
[2,]   0.85 592.64   0.90   0.87
[3,]   0.72   0.90 548.57   0.95
[4,]   0.64   0.87   0.95 575.21
```

```
> ## Table 5.5(b)
> ## REMLE AD(1)
> a<- cov.cor(REMLE.cov(speech[ ,2:5], covariate ,1, REMLE=TRUE))
> a
            [,1]        [,2]        [,3]        [,4]
[1,] 403.7433797   0.8530278   0.7680805   0.7278291
[2,]   0.8530278 592.6365471   0.9004168   0.8532302
[3,]   0.7680805   0.9004168 547.0262374   0.9475947
[4,]   0.7278291   0.8532302   0.9475947 543.5895444
> round(a,2)
       [,1]   [,2]   [,3]   [,4]
[1,] 403.74   0.85   0.77   0.73
[2,]   0.85 592.64   0.90   0.85
[3,]   0.77   0.90 547.03   0.95
[4,]   0.73   0.85   0.95 543.59

> ## REMLE AD(2)
> a<- cov.cor(REMLE.cov(speech[ ,2:5], covariate ,2, REMLE=TRUE))
> a
            [,1]        [,2]        [,3]        [,4]
[1,] 403.7433797   0.8530278   0.7177508   0.6946023
[2,]   0.8530278 592.6365471   0.8998702   0.8659155
[3,]   0.7177508   0.8998702 548.5730517   0.9472570
[4,]   0.6946023   0.8659155   0.9472570 541.0877231
> round(a,2)
       [,1]   [,2]   [,3]   [,4]
[1,] 403.74   0.85   0.72   0.69
[2,]   0.85 592.64   0.90   0.87
[3,]   0.72   0.90 548.57   0.95
[4,]   0.69   0.87   0.95 541.09

##difference of AD(1) and AD(3)
> cov.cor(REMLE.cov(speech[ ,2:5], covariate ,1,  REMLE=TRUE))-
cov.cor(REMLE.cov(speech[ ,2:5], covariate ,3, REMLE=TRUE))

           [,1]          [,2]          [,3]          [,4]
[1,] 0.00000000  0.0000000000  0.0503297593  8.646623e-02
[2,] 0.00000000  0.0000000000  0.0005465982 -1.406425e-02
[3,] 0.05032976  0.0005465982 -1.5468142506  1.794421e-04
[4,] 0.08646623 -0.0140642485  0.0001794421 -3.161585e+01

##difference of AD(2) and AD(3)
> cov.cor(REMLE.cov(speech[ ,2:5], covariate ,2,  REMLE=TRUE))-
cov.cor(REMLE.cov(speech[ ,2:5], covariate ,3, REMLE=TRUE))
           [,1]         [,2]          [,3]          [,4]
[1,] 0.00000000  0.000000000  0.0000000000  5.323949e-02
[2,] 0.00000000  0.000000000  0.0000000000 -1.379004e-03
[3,] 0.00000000  0.000000000  0.0000000000 -1.582894e-04
[4,] 0.05323949 -0.001379004 -0.0001582894 -3.411768e+01
```

Theorem 5.8(c):

Theorem 5.8(d):

```
>## REML estimates of the mean structure parameters for the first-order
model(p.150)
> beta.hat(speech[ ,2:5], covariate ,1)
         [,1]
[1,] 28.51950
[2,] 19.39571
[3,] 49.14400
[4,] 38.24143
[5,] 55.87122
[6,] 44.48888
[7,] 63.56950
[8,] 46.89875


>## REML estimates of the mean structure parameters for AD(2) model
> beta.hat(speech[ ,2:5], covariate ,2)
         [,1]
[1,] 28.51950
[2,] 19.39571
[3,] 49.14400
[4,] 38.24143
[5,] 55.91789
[6,] 44.24044
[7,] 63.48589
[8,] 46.78453


>## REML estimates of the mean structure parameters for AD(3) model
> beta.hat(speech[ ,2:5], covariate ,3)
         [,1]
[1,] 28.51950
[2,] 19.39571
[3,] 49.14400
[4,] 38.24143
[5,] 55.91789
[6,] 44.24044
[7,] 64.22370
[8,] 46.81729
```