

1. (From exam 2, Fall, 2005) An experiment measures “Ortho-P” reduction after running material through a centrifuge and adding either lime only (L) or an experimental flocculant only (F), or both (LF) or neither (C). $N = 12$ total samples are randomized to the four treatment combinations and run through the centrifuge. (Data are available as “centrifuge.dat”.)
 - (a) Obtain the sum of squares for treatments (based on 3 df).
 - (b) Obtain the sums of squares for three single degree-of-freedom contrasts to quantify
 - interaction between lime and flocculant ($SS(l * f)$)
 - main effect of lime $SS(l)$
 - main effect of flocculant $SS(f)$.
 - (c) Does adding lime improve Ortho-P reduction? Address this question by obtaining 95% confidence intervals for the simple lime effects in the absence or presence of the flocculant.
 - (d) Obtain an interaction plot to convey the effects of the treatments on Ortho-P reduction.
2. Rao 13.10
3. Rao 13.14
4. Rao 13.23
(Assignment is extended [here](#), updating previous version of HW4, which was shorter.)
5. Consider the data from exercise 13.31 (p. 632).
(See the code entitled “sleep.sas”). Note that while the means for all $t = abc = 12$ treatment combinations are given, the triplicate ($n = 3$) observations are not. The error mean square from the full ANOVA is $MS(E) = 1.43$ on $df = 24$.
 - (a) part a
 - (b) part b
 - (c) part c
 - (d) part d
 - (e) part e
 - (f) part f
 - (g) Estimate the two orthogonal polynomial contrasts for the effect of sleep deprivation on young folks: linear (θ_1) and quadratic (θ_2). (Average over gender.) Report the sums of squares for these two contrasts.
 - (h) Repeat part g for older folks (to obtain contrasts θ_3 and θ_4 and their sums of squares.)
 - (i) Consider two more contrasts, the linear sleep-by-age interaction, $\theta_5 = \theta_1 - \theta_3$ and the quadratic sleep-by-age interaction, $\theta_6 = \theta_2 - \theta_4$. Report sums of squares. Note that θ_5 and θ_6 are orthogonal and $SS(\theta_5) + SS(\theta_6) = SS(\text{age} \times \text{sleep})$.

6. Consider the unbalanced version of the cholesterol data for the four age-gender cohorts discussed in the notes. Report the contrast vectors of the form $(c_{11}, c_{12}, c_{21}, c_{22})$ needed to obtain the least squares estimates of the marginal means for men, for women and for the four combinations of age and gender. Report the estimates based on the data (fill in the table given on 149 of the lecture packet.)