1. In the data set hodg, times to death or relapse (in days) are given for 23 non-Hodgkin’s lymphoma (NHL) patients, 11 receiving an allogenic (Allo) transplant from an HLA-matched sibling donor and 12 patients receiving an autologous (Auto) transplant. Also, data on 20 Hodgkin’s lymphoma (HOD) patients, 5 receiving an allogenic transplant from an HLA matched sibling donor and 15 patients receiving an autologous transplant is given.

(i) Treating NHL Allo as the baseline hazard function, state the appropriate coding which would allow the investigator to test for any difference in survival functions for the four groups, treating them as four independent groups.

(ii) Treating NHL Allo as the baseline hazard function, state the appropriate coding which would allow the investigator to test for an interaction between type of transplant and disease type using main effects and interaction terms.

(iii) Suppose that we have the following model for the hazard rates in the four groups:

\[
h(t|\text{NHL Allo}) = h_0(t),
\]
\[
h(t|\text{HOD Allo}) = h_0(t) \exp(2),
\]
\[
h(t|\text{NHL Auto}) = h_0(t) \exp(1.5),
\]
\[
h(t|\text{HOD Auto}) = h_0(t) \exp(0.5).
\]

What are the coefficients, \( \beta_j, j = 1, 2, 3 \), for the interaction model in (ii)?

2. Continuing Problem 1, using Efron method of handling ties,

(i) Performing a global test of no effect of group as defined in 1(i) on survival.

(ii) Repeat part (i) using the coding in 1(ii).

(iii) Test the hypothesis of no interaction between disease type and transplant type, using likelihood ratio test. Repeat using the Wald test.

(iv) Find the point estimate and 95% confidence intervals for the relative risk for an NHL Auto transplant patient as compared to an NHL Allo transplant patient.
(v) Find the \( p \)-value of a test of the hypothesis that the hazard rates are the same for HOD Allo patients and NHL Allo patients, using the Wald test.

(vi) Test the hypothesis, using the Wald test, that the hazard rates for Auto transplant and Allo transplant patients are the same for each disease group against the alternative that the hazard rates for Auto transplant and Allo transplant patients for at least one group are different.