Computational Methods in Structural Dynamics, Final Winter 2005

One 8.5" by 11" cheat sheet. Problems are 10 points each.

Short answer (4 points each)

1. What does self-adjointness of a system mean physically? i.e. how can you use this to your advantage as an engineer?
2. Why is Householder's method preferred over Given's method?
3. On what fact is the Rayleigh-Ritz method based?
4. What is Lyapunov's (first) definition of stability?
5. Applying an additional single constraint to a system does what to its natural frequencies?
6. What types of problems require the use of weighted residual methods in place of the Rayleigh-Ritz method? (hint: 2 types).

Full-length problems. 20 points each.

1. The equation of motion of a simply supported beam string is given by: $EI\frac{\partial^4 w(x,t)}{\partial x^4} + \rho A \frac{\partial^2 w(x,t)}{\partial t^2} = 0$. Consider suspending a mass from the center of the string and its impact on the strings fundamental frequency. Find upper and lower approximate bounds on the system's fundamental frequency by a) treating the attaching spring as rigid, and b) treating it as infinitely compliant. Use only a one term representation of the mode.
2. Given the mass matrix $M = I$ and the stiffness matrix

$$K = \begin{bmatrix} 3 & -1 & 0 \\ -1 & 3 & -2 \\ 0 & -2 & 5 \end{bmatrix}$$

   use Green's method to estimate the first natural frequency presuming an initial mode shape guess of $[1; 1; 1]$. Perform 3 iterations, documenting the estimate of the mode shape and *natural frequency* after each iteration.
3. A constant-value compressive load of P is applied to a beam. Derive the governing equation/s of motion and the allowable boundary conditions.