Summary of Methodology for Dynamic Response Analysis

AE 6230 Notes
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Consider a structural dynamic system excited by distributed forces and discrete prescribed forces or motions at the boundaries. Recalling our previous discussion on dynamic response in the context of modal analysis, one could summarize the application of that methodology in the following sequence of steps:

1. Find a transformation that will remove all nonhomogeneous boundary conditions, replacing them with a nonhomogeneous forcing function in the partial differential equation(s).

2. Ignoring all nonhomogeneous terms and damping in the governing equations for the moment, find the modes and frequencies associated with the homogeneous, undamped system.

3. Substitute all these modes back into the governing equations or energy principle and obtain the generalized equations of motion. This will be a system of uncoupled ordinary differential equations if the forcing functions are not dependent on the generalized coordinates. (Note that using a truncated set of these modes is equivalent to using Galerkin's method or the Rayleigh-Ritz method.)

4. If these equations are uncoupled, solve them by an appropriate method for one-degree-of-freedom problems.

5. If these equations are coupled (by virtue of having taken forces into account which depend on the generalized coordinates), solve them by means of a method which is appropriate for multi-degree-of-freedom problems.

It may turn out that step 2 is too difficult. In this case, we can change the above procedure just a bit:

1. Find a transformation that will remove all nonhomogeneous boundary conditions, replacing them with a nonhomogeneous forcing function in the partial differential equation(s).

2. Ignoring all nonhomogeneous terms in the governing equations for the moment, determine an appropriate set of admissible or comparison functions for the homogeneous system.

3. Substitute these functions back into the governing equations or energy principle and obtain a set of coupled ordinary differential equations.

4. Solve these equations by means of a method which is appropriate for multi-degree-of-freedom problems.

The solution of multi-degree-of-freedom problems was addressed earlier in the course, and need not be addressed again here.