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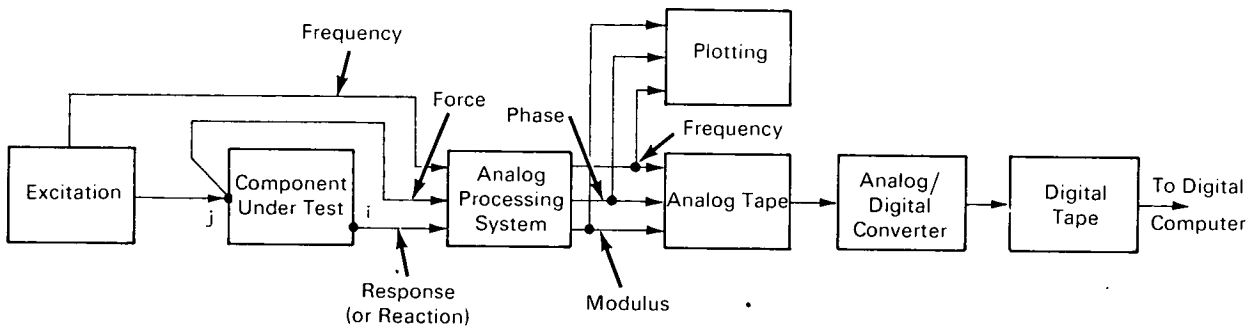
NASA TECH BRIEF

Analysis of Space Vehicle Structures Using the Transfer-Function Concept



Experimental Determination of Transfer Functions

The problem:

A direct analysis of the dynamical and vibrational behavior of large complex systems usually is not practicable, even with the most powerful computers presently available. Similarly, it is frequently not feasible to conduct dynamic tests because the systems are too large and different parts may undergo assembly at different geographical locations.

The solution:

Divide the system into suitable subsystems; determine the dynamical and vibrational response of the individual subsystems and then, by use of frequency transfer functions (the steady-state response at one point due to a unit amplitude sinusoidal input at another point), determine the vibrational response of the whole system.

How it's done:

The subsystem transfer functions can be determined either by analytical or experimental techniques. In the analytical determination, a modal analysis gives the normal modes representing the response, the modal frequencies and the general masses; the appropriate boundary conditions are imposed during the modal analysis as required by the assumed model.

Experimentally, as shown in the diagram, the transfer functions are determined by exciting the structure with a shaker producing an input force that closely approximates a sine wave; the frequency is slowly varied while monitoring the output response. The modulus of the output/input ratio and the phase angle between the input and output are recorded after undergoing several processing steps.

The matrices of the subsystem transfer functions involving respectively, response and excitation points, response and coupling points, only couple points, and coupling and excitation points are then formed to obtain the complete system matrix. This matrix is then prepared for computer processing which performs computations of the component and system matrixes, the deterministic time response or the spectral densities due to random excitations.

(continued overleaf)

Notes:

1. The technique of transfer-function coupling of subsystems is particularly useful in connection with experimental work in which only the subsystems are amenable to measurements and the experimental equipment substantially influences the measured results.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10337

Patent status:

No patent action is contemplated by NASA.

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