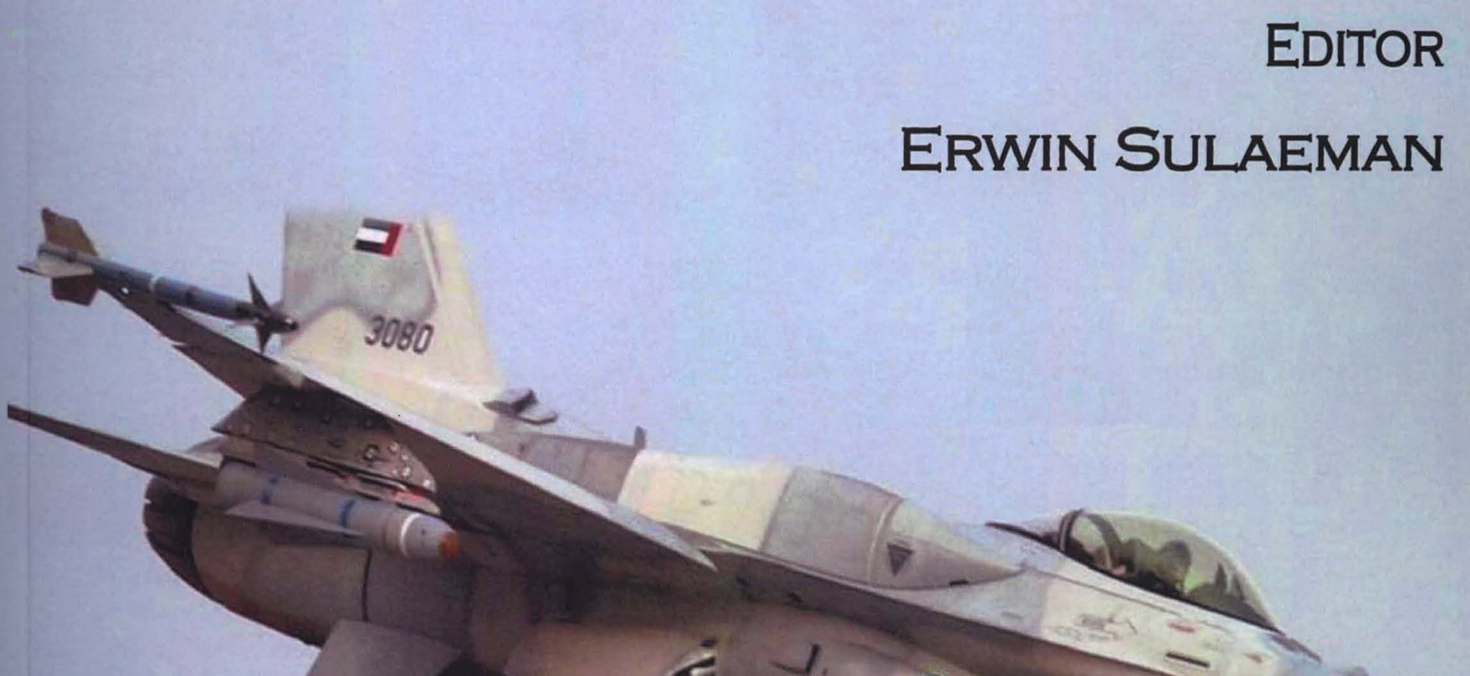
SELECTED TOPICS

In Aerospace Engineering

EDITOR

ERWIN SULAEMAN



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15.1. Introduction

This chapter describes the procedure to develop the flexural stiffness matrix of beam element having arbitrary variation of bending stiffness distribution along its span. To obtain analytical formulation, the stiffness matrix is constructed from the flexibility matrix. A Bernoulli-Euler differential equation that relates the load and deformation angle derived first. The general rational function resulting from the integration of the Bernoulli-Euler is transform to a simpler rational function using the DMRF procedure given in Chapter 21. The translation axis procedure given in Chapter 20 is used to efficiently construct the stiffness matrix.

15.2. Load - Displacement Relation

Stiffness matrix formulation for a beam bending problem is more involved than the formulation for axial and torsional problems. Consider a tapered beam element of length L made of an isotropic elastic material of modulus E as shown in Fig. 23.1. Similar to the assumption adopted by Gallagher and Lee in [15], shear deflections and rotatory inertia effects are neglected for the present model. In the present section, we assume that the cross-coupling moment of inertia $I_{yz} = 0$. The treatment for $I_{yz} \neq 0$ is presented in [35]. The moment of inertia $I = I(x)$ about the z axis varies as an arbitrary polynomial function in x as follow:

$$I(x) = I_c \prod_{j=1}^{N} \left(x - c_j\right)^{m_j} \tag{15.1}$$