Finite Element Method

MAT514

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Preface

This is a compilation of lecture notes with some books and my own thoughts. If there are any mistake/typing error or, for any query mail me at mehedi12@student.sust.edu.

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Part I

Sheet

$$F_{Ax} = -\left(p_0 + \frac{\delta x}{2} \cdot \frac{\partial}{\partial x}\right) \delta y \cdot \delta z$$

Chapter 1

Introduction

1.1 The Atmospheric Continuum

Dynamic meteorology is the study of those motions of the atmosphere that are associated with weather and climate.

1.2 Fundamental Forces

Body force act on the center of mass of a fluid parcel; they have magnitude proportional to the mass of the parcel. Gravity is an example of a body force.

Surface forces act across the boundary surface separating a fluid parcel from its surroundings; their magnitudes are independent of the mass of the parcel. The pressure force is an example.

Forces:

1. Fundamental Forces

    (a) Pressure Gradient Force
    (b) Friction Force
    (c) Gravitational Force

2. Apparent/Pseudo force

    (a) Centrifugal Force
    (b) Coriolis Force

1.3 Pressure Gradient Force

Consider, an infinitesimal volume element of air, $\delta V = \delta x \cdot \delta y \cdot \delta z$, centered at the point (x_0, y_0, z_0). Due to random molecular motions, momentum is continually imparted to the walls of the volume element by the surrounding air. This momentum transfer per unit time per unit area is just the pressure exerted on the walls of the volume element by the surrounding air.

If the pressure at the center of the volume element is designated by p_0, then the pressure on the wall A is,

$$p_0 + \frac{\delta x}{2} \cdot \frac{\partial}{\partial x} + \text{ higher order terms.} \qquad \text{[By Taylor series expansion]}$$

Neglecting the higher order terms in this expansion, the pressure force acting on the volume element at wall A is,

$$F_{Ax} = -\left(p_0 + \frac{\delta x}{2} \cdot \frac{\partial}{\partial x}\right) \delta y \cdot \delta z$$

where, $\delta y \cdot \delta z$ is the area of wall A.
Similarly,

$$F_{Bx} = +\left(p_0 - \frac{\delta x}{2} \cdot \frac{\partial}{\partial x}\right) \delta y \cdot \delta z$$