

A Finite Element Solution of the Beam Equation via MATLAB

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Abstract

The vertical deflection of a simply supported and clamped beam is considered under a uniform load using the finite element method. The problem is solved using homogenous and non-homogenous boundary conditions with various numbers of elements. The governing differential equation is that pre-described by the Bernoulli beam which is a fourth order differential equation. Cubic elements are used as required for continuity. Graphs are presented and discussed for different loads in each case.

Keywords: Finite element method, Beam equation, Homogenous and non-homogenous conditions

1. Introduction

Beam equations have historical importance, as they have been the focus of attention for prominent scientists such as Leonardo da Vinci (14th Century) and Daniel Bernoulli (18th Century). Practical applications of the beam equations are evident in mechanical structures built under the premise of beam theory. The importance of beam theory has been outlined in the literature over the years (see for example [3], [4], [5]). Examples include the construction of high-rise buildings, bridges across the rivers, air craft and heavy motor vehicles. In these structures, beams are used as the basis of supporting structures or as the main-frame foundation in axles. Without a proper knowledge of beam theory, the successful manufacture of such structures would be unfeasible and unsafe. The Euler-Bernoulli beam theory, sometimes called the classical beam theory, is the most commonly used. It is simple and provides reasonable engineering approximations for many problems. In the paper, we shall illustrate the use of the Galerkin Finite Element Method to solve the beam equation with aid of Matlab.

The Finite Element Method (FEM) is one of the most powerful tools used in structural analysis. Finite Element Analysis is based on the premise that an approximate solution to any complex engineering problem can be reached by subdividing a larger complex structure into smaller non-overlapping components of simple geometry called finite elements or elements. Complex, partial differential equations that describe these structures can be reduced to a set of linear equations that can easily be solved using this method.

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Agegnehu Bitew, Abebech Abera
Beyene, Solomon Workneh
Fanta, Addisu Negash Ali**

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The Finite Element Method Using MATLAB Young W. Kwon, Hyochoong Bang, 2018-10-03 Expanded to include a broader range of problems than the bestselling first edition *Finite Element Method Using MATLAB Second Edition* presents finite element approximation concepts formulation and programming in a format that effectively streamlines the learning process It is written from a general engineering and mathematical perspective rather than that of a solid structural mechanics basis What's new in the Second Edition Each chapter in the Second Edition now includes an overview that outlines the contents and purpose of each chapter The authors have also added a new chapter of special topics in applications including cracks semi infinite and infinite domains buckling and thermal stress They discuss three different linearization techniques to solve nonlinear differential equations Also included are new sections on shell formulations and MATLAB programs These enhancements increase the book's already significant value both as a self study text and a reference for practicing engineers and scientists [The Finite Element Method: Its Basis and Fundamentals](#) O. C. Zienkiewicz, R. L. Taylor, J.Z. Zhu, 2005-05-26 The Sixth Edition of this influential best selling book delivers the most up to date and comprehensive text and reference yet on the basis of the finite element method FEM for all engineers and mathematicians Since the appearance of the first edition 38 years ago *The Finite Element Method* provides arguably the most authoritative introductory text to the method covering the latest developments and approaches in this dynamic subject and is amply supplemented by exercises worked solutions and computer algorithms The classic FEM text written by the subject's leading authors Enhancements include more worked examples and exercises With a new chapter on automatic mesh generation and added materials on shape function development and the use of higher order elements in solving elasticity and field problems Active research has shaped *The Finite Element Method* into the pre eminent tool for the modelling of physical systems It maintains the comprehensive style of earlier editions while presenting the systematic development for the solution of problems modelled by linear differential equations Together with the second and third self contained volumes 0750663219 and 0750663227 *The Finite Element Method Set* 0750664312 provides a formidable resource covering the theory and the application of FEM including the basis of the method its application to advanced solid and structural mechanics and to computational fluid dynamics The classic introduction to the finite element method by two of the subject's leading authors Any professional or student of engineering involved in understanding the computational modelling of physical systems will inevitably use the techniques in this key text [Advances of Science and Technology](#) Mulugeta Admasu Delele, Mekuanint Agegnehu Bitew, Abebech Abera Beyene, Solomon Workneh Fanta, Addisu Negash Ali, 2021-07-15 This two volume set constitutes the refereed post conference proceedings of the 8th International Conference on Advancement of Science and Technology ICAST 2020 which took place in Bahir Dar Ethiopia in October 2020 The 74 revised full papers were carefully reviewed and selected from more than 200 submissions of which 157 were sent out for peer review The papers present economic and technologic developments in

modern societies in 6 tracks Chemical food and bio process engineering Electrical and computer engineering IT computer science and software engineering Civil water resources and environmental engineering Mechanical and industrial engineering Material science and engineering

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