NUMERICAL EXPERIMENTS FOR ANALYSIS OF VIBRATIONS OF TWO DIMENSIONAL PLATES

ABSTRACT
of
THESIS

Submitted to
Babasaheb Bhimrao Ambedkar University
(A Central University)
Lucknow

BABASAHEB
BHIMRAO
AMBEDKAR
UNIVERSITY

LUCKNOW

प्रज्ञा शील करुणा
ESTABLISHED 1996

for the award of the Degree of

Doctor of Philosophy
in
APPLIED MATHEMATICS

Under the supervision of
Prof. VIPIN SAXENA

Research Scholar
NEETU SINGH
Enrollment No. 1007/14

DEPARTMENT OF APPLIED MATHEMATICS
SCHOOL FOR PHYSICAL SCIENCES
BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
(A CENTRAL UNIVERSITY)
VIDYA VIHAR, RAEBARELI ROAD, LUCKNOW-226 025
UTTAR PRADESH, INDIA

2021

ABSTRACT

The present research work is the study on "**NUMERICAL EXPERIMENTS FOR ANALYSIS OF VIBRATIONS OF TWO DIMENSIONAL PLATES"** through Rayleigh-Ritz technique, computer based programming and MATLAB simulation tool. The shapes of plate may be circular, rectangular, square, quarter elliptic with different types of boundary conditions either clamped, simply-supported or completely-free and thickness variations may be linear, exponential and transcendental. The Classical plate theory is induced for all equations for the formulation of the problems. Rayleigh-Ritz technique is an approximate technique and operated by advisable continuous basis function, which considers all types of boundary conditions for a given problem. The presented technique is capable to generate the successive sequence of approximations to establish excellent convergence of results. The whole strategy is implemented through computer programming language like FORTRAN and MATLAB version simulation tool is used for designing the mode shapes, etc. First three natural frequencies have been computed and presented through tables and graphs though MS-Excel, generalized Jacobi method is used for computation of eigenvalues and eigenvectors. In special cases, the computed results are in excellent match with the results available in the literature. The chapter-wise summary is briefly discussed below:

In the Chapter I, causes of vibration, type of vibration, requirements for vibration, Classical plate theory, boundary conditions, types of plate like circular plate, rectangular plate, elliptic plate, skew plate, transverse vibration, Rayleigh method, Ritz method and Rayleigh-Ritz method are briefly discussed. This is an introductory chapter giving information all about the fundamentals used in the present research

work alongwith the concepts of the programming language FORTRAN and MATLAB simulation tool and convergence of results.

Chapter II deals with the information about the important and useful literature available on the beams and plates. In this section, all existing literatures are explained for different types of plates, beams, shells, Classical Plate theory, boundary conditions and different type of methodologies which are used to obtain natural frequencies, mode shapes with continuous basis function, aspect ratio and varying thickness.

In the Chapter III, the actual research work is presented for a quarter of an elliptic plate with exponential thickness by the use of Rayleigh-Ritz method which is very efficient to compute first three natural frequencies with some selected boundary conditions fixed at three edges and taper parameter. Convergence results for quarter of elliptic plate with exponential boundary conditions are computed upto five significant digits and in special cases, the computed results are in good agreement with the existing results in the literature.

Chapter IV deals with the study on the numerical computing of frequencies for rectangular and square plates with transcendental thickness variation. First time, transcendental thickness variation is used on aforesaid plates for getting the natural frequencies in different cases of boundary conditions although it satisfies the boundary conditions of the plate. Further, a well known Rayleigh-Ritz technique is used for computing the natural frequencies and mode shapes which are representing the behaviour of the plate. Computed frequencies are in increasing form due to increase in the taper parameter and results are correct upto five significant digits. In special cases, the computed results are in good match with the existing results available in the literature.

In the Chapter V, again a well known Rayleigh-Ritz method is used for clamped, simply-supported and completely-free for circular plate with transcendental thickness variation. Computed numerical results are in increasing form because taper parameter is increasing and stiffness of the plate is increasing. Results of circular plate are obtained correct upto five significant digits. Convergent table in the case of completely clamped and simply-supported of circular plate is presented and results are compared in special cases with the existing results available in the literature.

Chapter VI deals with the computation of first three frequencies for skew plate with linear and exponential thickness variations. First time exponential thickness variation is used on aforesaid plate for getting the natural frequencies in different cases of boundary conditions although it satisfies the boundary conditions of the plate. Further, a well known Rayleigh-Ritz technique is used for computing the natural frequencies of the plate. Computed frequencies are in increasing form due to increase in the taper parameter and results are correct upto five significant digits. In special cases, the computed results are in good match with the existing results available in the literature.

The last chapter of thesis is related to the conclusions and future scope of the work. In the present work, quarter of an elliptic, circular, rectangular, square, and skew plates have been studied on the linear, transcendental and exponential thickness variations by the use of Rayleigh-Ritz method. The same plates may be studied by the use of Finite Element method and other Polynomial methods. Further, other kinds of plates may be studied for future extension of the present research work.

LIST OF PUBLICATIONS

A. JOURNALS

1. **Neetu Singh and Vipin Saxena,** "Numerical Experiment on Quarter of an Elliptic Plate with Exponential Thickness Variation", **International Journal of Mathematics Trends and Technology (IJMTT), ISSN (2231-5373), Vol. 50(5), 279-286, Oct 2017.**
2. **Neetu Singh and Vipin Saxena,** "Numerical Computing of Frequencies for Rectangular and Square Plates with Transcendental Thickness Variation", **International Journal of Recent Technology and Engineering (IJRTE, Scopus), ISSN (2277-3878), Vol. 8(2), 4017-4030, July 2019.**
3. **Neetu Singh and Vipin Saxena,** "Numerical Computation of First Three Frequencies for Circular Plate with Transcendental Thickness Variation", **International Journal of Recent Technology and Engineering (IJRTE), ISSN (2277-3878), Vol. 8(6), 4017-4030, March 2020.**
4. **Neetu Singh and Vipin Saxena,** "Numerical Experiments on Skew Plate with Linear and Exponential Thickness Variations", **Strad Research (Web of Science Group), ISSN (0039-2049), Vol. 8(5), 13-27, April 2021.**

B. CONFERENCES

B.1 INTERNATIONAL CONFERENCES

5. "Transverse Vibration of a Quarter of a Circular with Exponential Thickness", Presented in **International Conference on Recent Advances in PDE: Theory Computation and Applications,** held at **Indian Institute of Technology, Bombay, during June 8-10th, 2017.**
6. "Numerical Computation of First Few Frequencies for Rectangular Plate with Transcendental Thickness Variation", Presented in **International Conference**

on Mathematical Modelling, Applied Analysis and Computation (ICMMAAC), held at **Department of Mathematics and Statistics, School of Science, JECRC University, Jaipur, Rajasthan, during July 6-8th, 2018.**

B.2 NATIONAL CONFERENCES

7. "Variational Method for Solution of Vibration of Plate", Presented in 3rd Lucknow Science Congress and National Conference on "Science for Society: An Interdisciplinary Approach, held at Babasaheb Bhimrao Ambedkar University, Lucknow, during Oct 31-2 Nov, 2015.

8. "A Study of Vibrations of Plates", Presented in National Conference on Mathematical Techniques in Engineering and Technology (MTET), held at Department of Applied Mathematics, School of Physical Sciences, Babasaheb Bhimrao Ambedkar University, Lucknow, during March 30-31, 2016.

9. "Vibration Problem on Plates", Presented in 4rd Lucknow Science Congress LUSCON-2017, Science Technology and Innovations for Sustainable Development held at Babasaheb Bhimrao Ambedkar University, Lucknow, during March 3-4, 2017.

C. LIST OF WORKSHOP AND SEMINAR ATTENED

1. Two days National Seminar on "Development of Mathematical Principle with their Advancement in Computer Sciences" Organized by Department of Computer Application of the College Isabelia Thoburn College, Lucknow, 17-18 Nov, 2015.

2. Two Week Workshop on "Modeling Week and Study Group Meeting on Industrial Problems (MWSGMIP-2010)" Organized by National Program on Differential Equation: Theory Computation & Applications (NPDE-TCA) (Sponsored by Department of Science of Technology Government of India),

Institute of Technology & Management (ITM) Universe, Vadodara, 10-19 March, 2016.

3. Two days XXXII IATLIS National Conference on LIS Research: Issues and Challnges, held at Babasaheb Bhimrao Ambedkar University, Lucknow, during Dec 19-20, 2016.

4. One Week Workshop on "Emerging Research Trends in Computer Science, Organized by Department of Computer Science, School for Information Science & Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, 20-24 March, 2017.

5. One Week Workshop and Faculty Development Programme on "Research Methodology" Organized by Department of Computer Science & Engineering, Uttaranchal University, Dehradun, 4-9 Dec, 2017.

6. One Week Short Term Course on "Software Tools for Scientific Research: Mathematica and LATEX" Organized by Department of Mathematics and Mechanical Engineering (Sponsored by TEQIP-Phase III), MNIT Jaipur, 09-13 Jan, 2018.

7. Two Weeks Faculty Development Program on "Ensuring Excellence in Teaching/ Learning/ Research in Higher Educational Institutions Using ICT (ID)" Organized by Department of Information Technology, Babasaheb Bhimrao Ambedkar University, Lucknow, 22 Dec 2018-06 Jan, 2019.

8. One Week National Workshop on "Research Methodology" Organized by Faculty of Education, IGNTU, Amarkantak (MP), 26-30 May, 2020.

9. Online Quiz Competition on "National Level Quiz on Engineering Mathematics" Organized by Department of Mathematics, Mandsaur University, Mandsaur (WSSCWW-CE000170), 2020.

10. Online Quiz Competition on "Engineering Mathematics" Organized by Department ofHumanities & Mathematics, G. Narayanamma Institute of Technology & Science Shaikpet, Hyderabad, June 2020 (OAASMG-CE00 2153).

11. Six Days Faculty Development Programme on "Application of Mathematics in Diverse Fields" Organized by Department of Mathematics, Anand Institute of Higher Technology, Kazhipattur, Chennai, 26 June-04 July, 2020.

12. One Week Online Faculty Development Programme (FDP) on "Soft Computing Techniques and their Applications (SCTA 2020)" Organized by Department of Mathematics of Jaypee Institute of Information Technology, Noida, 13-18 July, 2020.

13. Three Days Online Short Term Training Programme (STTP) on "MATLAB and MATHEMATICA for Scientific Research" Organized by the Department of Mathematics, Arul Anandar College, Karumathur, Madurai, 27-29 July, 2020.

14. One Week Online FDP on "Mathematical Modelling & Numerical Technique 2020" Organized by the Department of Mathematics and Humanities, Kaktiya Institute of Technology and Science, Telangana, 27-31 July, 2020.

15. National Level Faculty Development Programme (FDP) on "MATLAB TOOLS & APPLICATIONS" Organized by the Department of Mathematics, Babu Banarasi Das Northern India Institute of Technology (AKTU College code: 056), Lucknow, 07-08, 10 August, 2020.

16. One Week Faculty Development Programme on "RESEARCH METHODOLOGY AND TECHNOLOGY LED PARADIGM SHIFT IN TEACHING AND LEARNING PROCESS" Organized by the Internal Quality

Assurance Cell, Research and Consultatncy Cell, P.G.DA.V. College (Evening) in Collaboration with Buniyaad Education Society, Delhi, 4-12 August, 2020.

17. National Level Webinar on "LaTex and its Applications" Organized by the Department of Computer Science, BCA & IQAC, SBRR Mahajana First Grade College (Autonomous), Mysuru, Karnataka, 19-08-2020.