

Circular Membrane User Guide

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1 Requirements

For running this application on your desktop computer, you must install JRE (Java Runtime Environment) on your computer. For more information on installing Java, refer to our guide on installing java.

2 Brief Description Of Circular Membrane¹

Circular membranes are important parts of drums, pumps, microphones, telephones, and other devices. This accounts for their great importance in engineering. Whenever a circular membrane is plane and its material is elastic, but offers no resistance to bending (this excludes thin metallic membranes!), its vibrations are modeled by the two-dimensional wave equation in polar coordinates obtained from (1) with ∇^2 given by (2), that is,

$$(1) \quad u_{tt} = c^2 \nabla^2 u = c^2 (u_{xx} + u_{yy})$$

$$(2) \quad \nabla^2 u = \frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{1}{r^2} \frac{\partial^2 u}{\partial \theta^2}$$

$$(3) \quad \frac{\partial^2 u}{\partial t^2} = c^2 \left(\frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} + \frac{1}{r^2} \frac{\partial^2 u}{\partial \theta^2} \right) \quad c^2 = \frac{T}{\rho}$$

We shall consider a membrane of radius R and determine solutions $u(r, t)$ that are radially symmetric. (Solutions also depending on the angle Then $u_{\theta\theta} = 0$ in (3) and the model of the problem is

$$(4) \quad \frac{\partial^2 u}{\partial t^2} = c^2 \left(\frac{\partial^2 u}{\partial r^2} + \frac{1}{r} \frac{\partial u}{\partial r} \right)$$

$$(5) \quad u(R, t) = 0 \quad \text{for all } t \geq 0$$

$$(6a) \quad u(r, 0) = f(r)$$

$$(6b) \quad u_t(r, 0) = g(r)$$

Here (5) means that the membrane is fixed along the boundary circle $r = R$. initial deflection $f(r)$ and the initial velocity $g(r)$ depend only on r , not on θ , so that we can expect radially symmetric solutions $u(r, t)$.

¹Advanced Engineering Mathematics 10th Edition, Erwin Kreyszig

3 How To Use The Application

For using this application you must download it from the followed link: <https://wp.kntu.ac.ir/aliakbarian/pde/visualizations/recutangular-membrane/RecutangularMemberaneFX.jar>

When you run the application something like figure 1 will be shown to you on the screen.

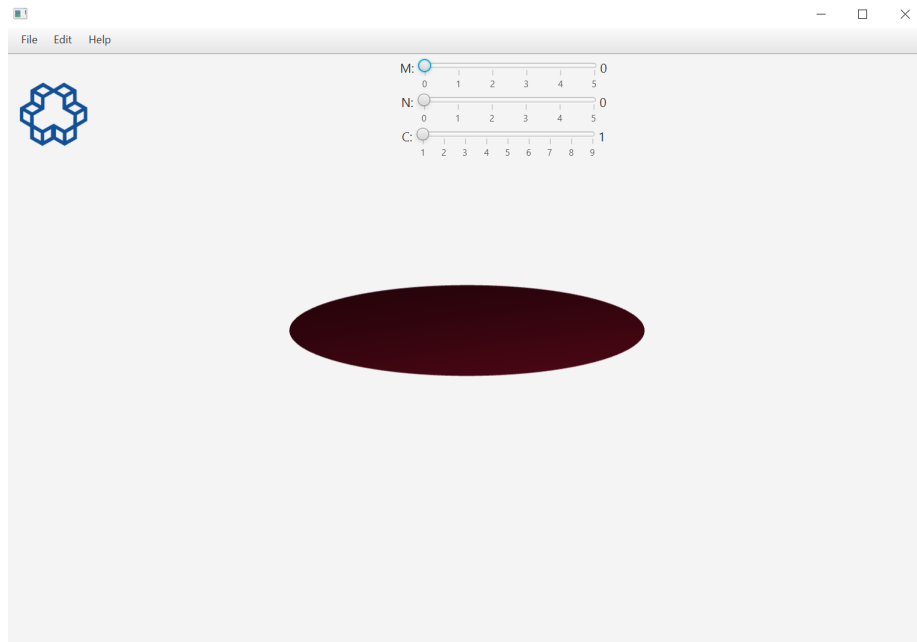


Figure 1: First Perspective

There are some buttons on top of the application, in File menu, you can save the result of your test as a picture, by next button you can start animation or stop it, you can set a time and take the 3d plot of that time, you be able to change appearance of the plot, and finally you can migrate between single mode and multi mode which I will explain later, and by the last one you can see some information about the application.

Now we start in single mode, at the top of the application you see three sliders like 2



Figure 2: Sliders

By m, n sliders you can increase and decrease nodal circle and nodal diameter respectively in circular membrane plot like 3

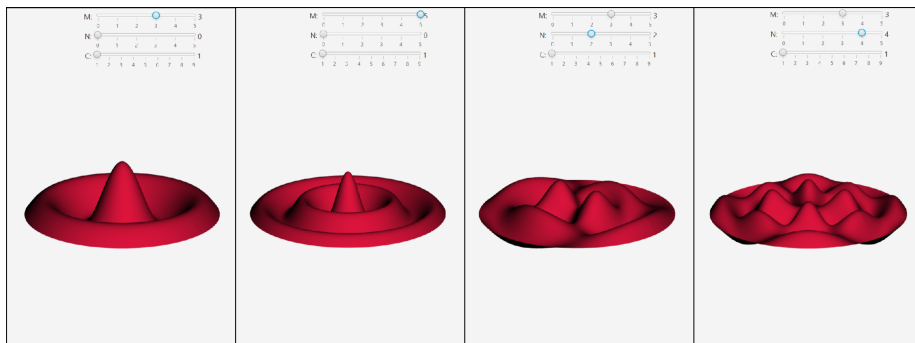


Figure 3: You Can Change Nodal Circle and Nodal Diameter Of Plot

Last slider can change the coefficient of the wave equation (c) like 4; And you will see as more as you increase the c , the plot will animate faster.

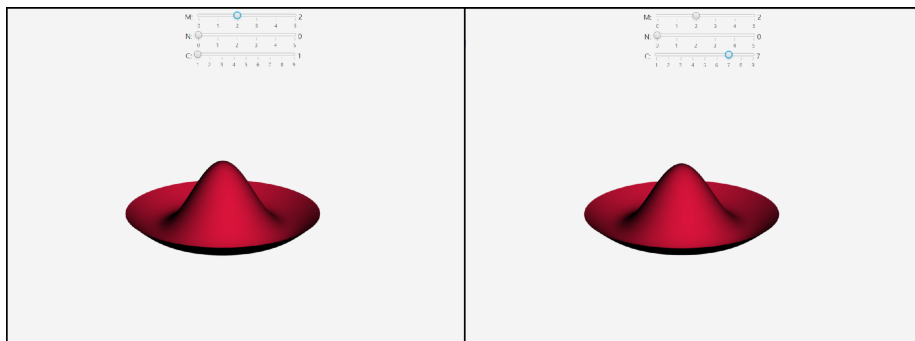


Figure 4: You Can Change The Coefficient Of The Equation

At the end I want to illustrate multi mode section, if you choose this mode some thing like 5 will be shown to you.



Figure 5: Multi Mode Perspective

Numbers next to the each mode define its nodal circle and nodal diameter, and by its slider you can modify the impact ratio of this mode in the circular membrane plot like 6.

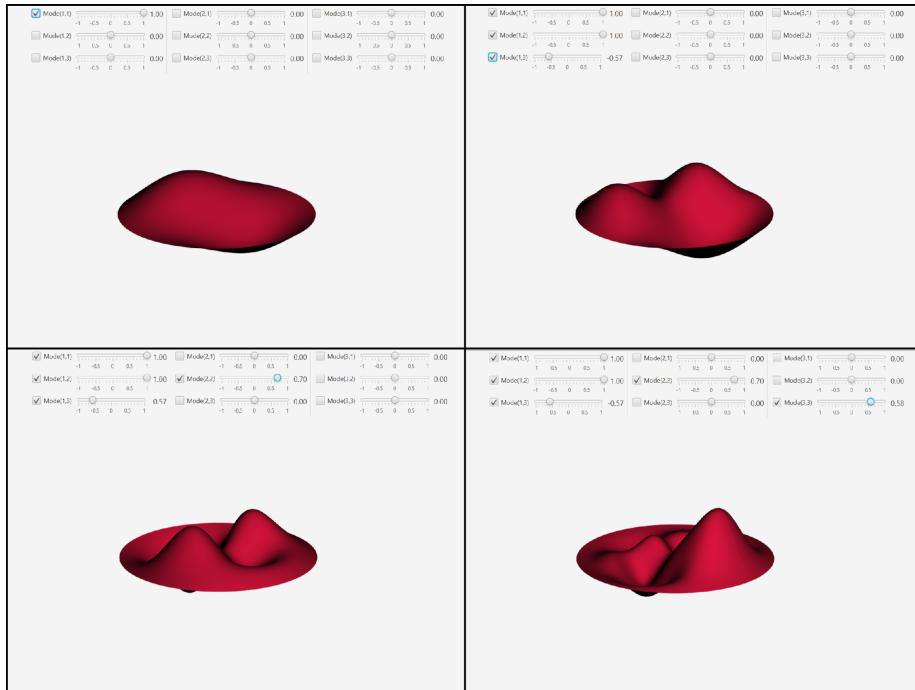


Figure 6: The Application Can Animate Membrane In Multi Mode

4 About Us

User guide is written by [Mahdi Kafi](#) on 11/17/2017

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