A 1  INTRODUCTION

Computational Ocean Acoustics Toolbox (COAT) is a package written containing the following topics which are described in the preceding Chapters.

1. Acoustic Quantity Conversion.  
2. Equation of State.  
3. Radiation by a Simple Acoustic Source.  
5. Nearfield Lloyd Mirror Pattern.  
6. Reflection Coefficients.  
7. Isovelocity Wave Guide.  
   (Analytical and Rayleigh-Ritz Solution).  
10. Shallow Acoustic Propagation.  

The package is written in MATLAB with Graphics User Interpretation. The toolbox will work only in the WINDOWS environment and the user need MATLAB (recommended version 2007 or latter) to be installed in his/her computer.

The complete package contains totally 195 MATLAB function and figures which are all equally needed to run the code, otherwise the code displays error massage ‘May Not Work Properly’ in the initial screen. All the functions and the figures are saved in the folder named as ‘Code’ and COAT.m is the calling function. Renaming of the folders and the functions are not allowed.

A 2  HOW TO RUN THE TOOLBOX

Change the MATLAB directory to the path where the folder Code and COAT.m were saved. Suppose the toolbox saved in the path ‘C:\Users\Amlan\Documents\MATLAB\COAT’ then type cd (‘C:\Users\Amlan\Documents\MATLAB\COAT’) in the MATLAB command window.
Type run ('COAT') in the command window to start the toolbox and then the initial screen Fig. A2 will pop out and you choose your problem by clicking the corresponding pushbutton.

A3 DESCRIPTION OF THE TOOLBOX

A 3.1 ACOUSTIC QUANTITY CONVERSION

Here user will able to calculate the basis acoustic quantity conversion that has some importance in the acoustical research. We try to give brief information to use this tool.
A 3.1.1 INVERSE SQUARE LAW

It will predicts the sound intensity level at some desired distance while the intensity level is known for a distance and also the level difference from the known level using MATLAB function ‘Inverse_Square_Law_Calc’ as described in Table 2.1. The user have to enter all the values to calculate the intensity level and level difference by pressing the pushbutton ‘Calculate’.

A 3.1.2 SOUND PRESSURE, INTENSITY AND THEIR LEVEL

Fig. A3 Inverse Square Law

Fig. A4 Sound Pressure and it’s level
It will calculates any three of the Sound Pressure, Sound Pressure Level, Sound Intensity and Sound Intensity Level while the value of the remaining one is known using MATLAB function ‘Sound_pressure_level_Acoustic_intensity_level_Calc’ as described in Table 2.2. Here the default reference sound pressure is 20 μPa and the sound intensity is 1 W/m². The user is allowed to do change in the reference values. The user has to enter at least one value among the four to calculate the remaining three by pressing the pushbutton ‘Calculate’.

A 3.1.3 ACOUSTIC POWER AND ACOUSTIC POWER LEVEL

Fig. A4 Acoustic Power and it’s level

It will calculates the Acoustic Power or Acoustic Power Level while the other quantity is known with some reference sound power using the MATLAB function ‘AcousticPower_to_AcousticPowerLevel_Calc’ as described in Table 2.3. Default reference sound power is 1 pW. The user allowed to change the reference sound power and the user have to enter either Acoustic Power or Acoustic Power Level to calculate the other one by pressing the pushbutton ‘Calculate’.

A 3.1.4 PARTICLE VELOCITY AND PARTICLE VELOCITY LEVEL

It will calculates the Particle Velocity or Particle Velocity Level while the other quantity is known with some reference sound power using the MATLAB function ‘Particle_velocity2velocity_level_calc’ as described in Table 2.4. Default reference particle velocity 5 x 10⁻⁸ m/s. The user allowed to change the reference particle velocity and the user
have to enter either Particle Velocity or Particle Velocity Level to calculate the other one by pressing the pushbutton ‘Calculate’.

Fig. A5 Particle Velocity and it’s level

A 3.1.5 SOUND ENERGY AND SOUND ENERGY LEVEL

Fig. A6 Sound Energy and it’s level

It will calculates the Sound Energy or Sound Energy Level while the other quantity is known with some reference sound energy using the MATLAB function ‘SoundEnergy2Energy_Level_
Calc’ as described in Table 2.5. Default reference sound energy is 1 pJ. The user allowed to change the reference sound energy and the user have to enter either Sound Energy or Sound Energy Level to calculate the other one by pressing the pushbutton ‘Calculate’.

A 3.1.6 SOUND ENERGY DENSITY AND SOUND ENERGY DENSITY LEVEL

Fig. A7 Sound Energy Density and it’s level

It will calculates the Sound Energy Density or Sound Energy Density Level while the other quantity is known with some reference sound energy density using the MATLAB function ‘SoundEnergyDensity2Level_Calc’ as described in Table 2.6. Default reference sound energy density is 1 pJ/m$^3$. The user allowed to change the reference sound energy density and the user have to enter either Sound Energy Density or Sound Energy Density Level to calculate the other one by pressing the pushbutton ‘Calculate’.

A 3.1.7 LOUDNESS AND LOUDNESS LEVEL

It will calculates the Loudness or Loudness Level while the other quantity is known using the MATLAB function ‘SoundEnergyDensity2Level_Calc’ as described in Table 2.7. The user have to enter either Loudness or Loudness Level to calculate the other one by pressing the pushbutton ‘Calculate’.
A 3.1.8 LEVEL CHANGE AND THE LOUDNESS FACTOR

It will calculates the Level change or Loudness factor while the other quantity is known for Psychyoacoustics, Field Quantity and Energy Quantity using the MATLAB function ‘Level_change_and_loudness_Factor_Calc’ as described in Table 2.8. The user have to enter either Level change or Loudness factor to calculate the other one by pressing the pushbutton ‘Calculate’.

A 3.1.9 OHM’S LAW AS ACOUSTIC EQUIVALENT

It will calculates any two of the Sound Pressure, Particle velocity, Acoustic Impedance and Sound Intensity while the value of the remaining two is known using MATLAB function
Ohms_law_Calc’ as described in Table 2.9. The user has to enter two values among the four to calculate the remaining two by pressing the pushbutton ‘Calculate’.

![Ohm’s Law as Acoustic Equivalent](image)

**Fig. A10 Ohm’s Law As Acoustic Equivalent**

**A 3.1.10 ADDING ACOUSTIC LEVELS**

![Combining Decibels](image)

**Fig. A11 Combining Decibels**
It will add up the acoustic levels (up to 10th level) using MATLAB function ‘Combining_decibels_Calc’ as described in Table 2.10. The user can enter at most 10 acoustic level to calculate the combining acoustic levels by pressing the pushbutton ‘Calculate’ and if user need to add less than ten levels then the remaining places can be left blank.

For all the GUI’s the pushbutton ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to the initial screen to choose another set of problems.

A 3.2 EQUATION OF STATE

Here user will able to calculate the ‘Density of Water’, ‘Sound Speed of Sea Water’ and Conversion of Pressure and Depth by clicking the appropriate pushbutton. We try to give brief information to use this tool.

A 3.2.1 DENSITY OF WATER

The user can calculate the density of water by using well known equations for density such as Millero’s Equation, Poisson’s Equation, International One Atmosphere Equation and International One High Pressure Equation using the MATLAB function ‘Seawaterdensity_Miller_Calc’, ‘Seawaterdensity_Poisson_Calc’, ‘Seawaterdensity_International_1atm_Calc’ and ‘Seawaterdensity_International_highpressure_Calc’ as described in the Table 3.2 a, 3.3 a, 3.1 a and 3.4 a respectively. For the first three user have to give both the temperature and salinity of the water to calculate the relative density, density of sea water and density of water and for the high
pressure equation user have to enter the pressure as well. The description of relative density, density of sea water and density of water are clearly are in Section 3.1.

Fig. A12 Density of Water

A 3.2.2 Sound Speed in Sea Water

The user can calculate the sound speed of water by using well known equations for sound speed such as Mackenzie’s Equation, Coppens’s Equation, Chen and Millero’s Equation and Del Grosso’s Equation using the MATLAB function ‘Sound_speed_Mackenzie_Calc’, ‘Sound_speed_speed_Coppen_Calc’, ‘Sound_speed_ChenandMillero_Calc’ and ‘Sound_speed_Del_Grosso_Calc’ as described in the Table 3.5 to 3.8 respectively. For the first two equations user has to give the temperature, salinity and depth of the water to calculate the sound speed and where as for the last two equations the depth will be replaced by pressure. The details are in Section 3.2.

Fig. A13 Sound Speed in Sea Water
A 3.2.3 CONVERSION OF PRESSURE AND DEPTH

User can able to find the pressure in the sea water at his desired depth at given latitude and vice versa by Leroy and Parthiot 1998 using the MATLAB function ‘Pressure_and_Depth_Calc’ as described in the Table 3.9.

![Conversion of Pressure and Depth](image)

Fig. A14 Conversion of Pressure and Depth

As the previous section ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

A 3.3 RADIATION BY SIMPLE ACOUSTIC SOURCE

It will plot the pressure amplitude for simple acoustic sources under water such as Monopole, Dipole, Quadrupole and Longitudinal Quadrupole for a fixed distance from the source or for a varying distance using MATLAB function ‘Sound_Field_Radiated_By_Simple_Sources_Calc’ as described in the Table 4.1. The user have to give the position of the sources as described in the following table along with the Density of the water, sound speed, source frequency and source strength for determining the pressure amplitude for all type of sources.

- **Monopole**: No extra input needed.
- **Dipole**: Horizontal Distance $(d)$ between two sources as described in section 4.3.
Quadrupole: Horizontal Distance \((d)\) and Longitudinal Distance \((D)\) between sources as described in section 4.4.

Longitudinal Quadrupole: Distance between two consecutive sources \((d)\) and the distance between each pair of sources \((D)\) pair as described in section 4.5.

Fig. A15 Different type of source

For each source type by clicking the pushbutton ‘Pressure Amplitude’ another screen will appear where the user has to give the distance from the source or the range of distance and the plot of pressure amplitude will appears whenever the user click ‘Pressure Plot’.

Fig. A16 Pressure Amplitude
As the previous section ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

A 3.4 WAVE EQUATION SOLUTION

Using this tool the user can solve one and three dimensional wave equation. Here basically the user can view the motion of the String (Semi-infinite and Finite) and mode shape of the Membrane (Rectangular and Circular) with respect to the time.

A 3.4.1 Semi-infinite String

It will solve the two dimensional wave equation with the appropriate initial and boundary condition as shown in the screen using the MATLAB function ‘Semi_Infinite_String_Calc’ as described in Table 5.1. User has to choose the wave speed, length of the string up to which the user wants to view the motion and the initial displacement and velocity as a function of x. The user has to follow the MATLAB convention to write the functions with the concept of ‘mpower’ otherwise it will give error. For example if \( f(x) = e^{-(x-5)^2} \) then the function must be written as \( \exp(-(x-5)^2) \).
The string will start to move with time whenever the user clicks the pushbutton ‘Run’. To resume the motion user have to click ‘Pause’ which will appear in the screen while the string is in motion. ‘Restart’ will start the motion from time = 0. The pushbutton ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

A 3.4.2 Finite String

This tool will work same as the Semi-infinite string. The only difference is that here user has to provide the length of the string. Here we use the MATLAB function ‘Finite_String_Calc’ as described in Table 5.2.

![Fig. A18 Semi-infinite String](image)

A 3.4.3 Circular Membrane

It will solve the three dimensional wave equation with the appropriate initial and boundary condition as shown in the screen using the MATLAB functions ‘ModeShape_Circular_Membrane_Calc’ and ‘Find_nth_bessel_root’ as described in Table 5.5 and 5.6. User has to choose the radius of the membrane, wave speed and the real integer value which denotes the two modes. The corresponding mode shape will start to move with time whenever the user clicks the
pushbutton ‘Run’. To resume the motion user have to click ‘Pause’ which will appear in the screen while the string is in motion. ‘Restart’ will start the motion from time = 0. The pushbutton ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

![Image: Circular Membrane](image)

**Fig. A19 Circular Membrane**

**A 3.4.2 Rectangular Membrane**

It will solve the three dimensional wave equation with the appropriate initial and boundary condition as shown in the screen using the MATLAB functions ‘ModeShape_Rectangular_Membrane_Calc’ as described in Table 5.8. User has to choose the dimension of the membrane (length and width), wave speed and the real integer value which denotes the two modes. The corresponding mode shape will start to move with time whenever the user clicks the pushbutton ‘Run’. To resume the motion user have to click ‘Pause’ which will appear in the screen while the string is in motion. ‘Restart’ will start the motion from time = 0. The pushbutton ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.
This is the characteristic field pattern in deep water by considering the acoustic interference pattern created by a point source placed near a smooth, perfectly reflecting sea surface. This tool will calculate the Transmission Loss and Pressure at a fixed depth and at a fixed range and also contour plot of Transmission Loss and Pressure using the MATLAB function ‘Pressure_and_TL_Nearfield_Calc’ as described in the Table 6.1. As an initial input the user has to give the Source Depth, Sound Speed, Frequency and Pressure at 1 m distance from the source (by default 1 Pa) and then according to the need user has to click the appropriate pushbutton to get the plot.
To calculate the TL and Pressure at fixed depth user has to give the Receiver depth and the range in which user want to see the pressure and TL. To calculate the TL and Pressure at fixed range user has to give the Receiver range and the depth in which user want to see the pressure and TL. For getting the contour plot user need to enter the range as well as the depth. For each case the tool will create an output file (name will be chosen by the user) saved in the location ‘C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Nearfield Lloyd Mirror Pattern’. The bold part of the path will be changed according to your location where the complete package COAT is saved.

Similarly for all the previous section ‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

**A 3.6 REFLECTION COEFFICIENTS**

The Lloyd mirror effect described above is a characteristic feature of the interaction of an acoustic field with smooth sea surface. However, the interaction with the bottom can be just as important, in particular in shallow water environment. This will plot Reflection coefficients and
Phase angle versus grazing angle using the MATLAB function ‘Reflection_Coefficient_Calc’ as described in Table 6.2. User need to provide the source frequency and the sound speed and density of the two medium in the initial screen to obtained the plots in the range of desired grazing angle. Range of grazing angle can be chosen from the GUI which will appear after clicking the pushbutton ‘Reflection Coefficients with phase and grazing angle’ in the initial screen.

![Fig. A21 Reflection Co-efficient](image1)
![Fig. A21 Grazing angle](image2)

‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

**A 3.7 ISOVELOCITY WAVE GUIDE (ANALYTICAL SOLUTION)**

The simplest model of this ocean waveguide is range independent isovelocity water column with perfectly reflection boundaries. This tool will calculate the Transmission Loss and Pressure at a fixed depth and at a fixed range and also contour plot of Transmission Loss and Pressure using the MATLAB function ‘Pressure_TL_Analytical_Isovelocity_waveguide_Calc’ as described in the Table 8.2. As an initial input the user has to give the Water Depth, Source Depth, Sound Speed, Source Frequency, Pressure at 1 m distance from the source (by default 1 Pa) and
tolerance (By default $1 \times 10^{-8}$) then according to the need user has to click the appropriate pushbutton to get the plot. The user can change the boundary condition by clicking the check box. The default boundary condition is ‘Pressure release Boundaries’ and the other two boundary condition are ‘Pressure release Top and Hard Bottom’ and ‘Hard Top and Hard Bottom’.

Fig. A22 Isovelocity Waveguide (Analytical)

The user can view the total number of propagating mode by clicking the pushbutton ‘Mode Shape’ and also entering an integer value (say $n$) in next screen you can plot the $n$ number of mode shape

Fig. A23 Mode Shape
To calculate the TL and Pressure at fixed depth user has to give the Receiver depth and the range in which user want to see the pressure and TL. To calculate the TL and Pressure at at fixed range user has to give the Receiver range and the depth in which user want to see the pressure and TL. For getting the contour plot user need to enter the range as well as the depth. For each case the tool will create an output file (name will be chosen by the user) saved in the location ‘C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Isovelocity Waveguide\Analytical’. Bold part of the path will be changed according to your location where the complete package COAT is saved.

Fig. A24 TL and Pressure Plot

‘Reset’ can be used to reset all the values in the corresponding GUI’s and the ‘Back’ will take the user to previous screen to choose other problems.

A 3.8 ISOVELOCITY WAVE GUIDE (RAYLEIGH-RITZ SOLUTION)

It can be used similarly as the analytical solution. Only here the user have upload or create a sound speed profile to run the code. User can upload a sound speed profile as a TEXT format from anywhere in the computer. Otherwise user can create a new sound speed profile by choosing the ‘Create’ box.
For the help of the user we will provide a sample of sound speed profile.

<table>
<thead>
<tr>
<th>No of Segment</th>
<th>No. of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>1500</td>
</tr>
<tr>
<td>100</td>
<td>1500</td>
</tr>
<tr>
<td>101</td>
<td>2000</td>
</tr>
<tr>
<td>150</td>
<td>2000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sound Speed (m/s)</th>
<th>Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1500</td>
<td>1000</td>
</tr>
<tr>
<td>100</td>
<td>1500</td>
<td>1000</td>
</tr>
<tr>
<td>101</td>
<td>2000</td>
<td>2000</td>
</tr>
<tr>
<td>150</td>
<td>2000</td>
<td>2000</td>
</tr>
</tbody>
</table>

If the user wants to create a new sound speed profile then user has to use the following screen or have to make a TEXT file as above.
To create the Sound Profile user have to enter the profile name, Number of Segment and No of station. Now in the next step if user needs to give Depth, Sound Speed and Density in the corresponding place and press update to write in a TEXT file. ‘Recreate’ will delete the old text file.

Transmission Loss and Pressure can be calculated in a similar process as the analytical solutions and here the output file will be saved in the location ‘C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Isovelocity Waveguide\Numerical’. The Bold part of the path will be changed according to your location where the complete package COAT is saved.

**A 3.9 PEKERIS WAVE GUIDE (ANALYTICAL SOLUTION)**

In this wave guide the bottom is more realistically represented by an infinite fluid half-space, allowing for energy to be transmitted across the water bottom interface and thereby introducing an additional loss mechanism to the waveguide propagation. This tool will calculate the Transmission Loss and Pressure at a fixed depth and at a fixed range and also contour plot of Transmission Loss and Pressure using the MATLAB function ‘Transcendental_Solve_Pekeries_Analytical’ and ‘Pressure_and_TL_Analytical_Pekeris_Calc’ as described in the Table 8.3 and 8.4. As an initial input the user has to give the Depth of the upper layer, Source Depth, Source Frequency, Pressure at 1 m distance from the source (by default 1 Pa) along with the density and sound speed of the two layers. Then according to the need user has to click the appropriate pushbutton to get the plot.

The user can view the total number of propagating mode by clicking the pushbutton ‘Mode Shape’. To calculate the TL and Pressure at fixed depth user has to give the Receiver depth and the range in which user want to see the pressure and TL. To calculate the TL and Pressure at at fixed range user has to give the Receiver range and the depth in which user want to see the
pressure and TL. For getting the contour plot user need to enter the range as well as the depth. For each case the tool will create an output file (name will be chosen by the user) saved in the location 'C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Pekeris Waveguide\Analytical'. Bold part of the path will be changed according to your location where the complete package COAT is saved.

Fig. A27 Pekeris Waveguide (Analytical)

Fig. A28 TL and Pressure Plot
A 3.10 PEKERIS WAVE GUIDE (RAYLEIGH-RITZ SOLUTION)

It can be used similarly as the analytical solution. Only here the user have upload or create a sound speed profile to run the code. User can upload a sound speed profile as a TEXT format from anywhere in the computer. Otherwise user can create a new sound speed profile by choosing the ‘Create’ box.

![Pekeris Waveguide Numerical](image)

Fig. A29 Pekeris Waveguide (Numerical)

For the help of the user we will provide a sample of sound speed profile.

<table>
<thead>
<tr>
<th>No of Segment</th>
<th>No of Stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>4</td>
</tr>
<tr>
<td>0</td>
<td>1500</td>
</tr>
<tr>
<td>100</td>
<td>1800</td>
</tr>
<tr>
<td>101</td>
<td>1800</td>
</tr>
<tr>
<td>150</td>
<td>1800</td>
</tr>
</tbody>
</table>

Depth (m) | Sound Speed (m/s) | Density (kg/m^3) |
0         | 1500             | 1000             |
100       | 1800             | 1800             |
101       | 1800             | 1800             |
150       | 1800             | 1800             |

If the user wants to create a new sound speed profile then user has to create it as described in the case of the Isovelocity rayleigh-ritz solution. For each case the tool will create an output file (name will be chosen by the user) saved in the location ‘C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Pekeris Waveguide\Numerical’.
A 3.11 SINGLE RAY TRACING

It will plot the ray path and the Transmission Loss and Pressure as well. User has to input the Source Depth, Source Frequency, Initial angle propagation, Receiver range, maximum range, and the range increment along with a sound speed profile that can be uploaded or created according to user’s wish.

Fig. A30 Ray Acoustics (Numerical)

For the help of the user we will provide a sample of sound speed profile.

<table>
<thead>
<tr>
<th>2 5</th>
<th>No of Radial Station</th>
<th>No of Depth Station.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range 1</td>
<td>Range 2</td>
</tr>
<tr>
<td>0.000</td>
<td>1522.0</td>
<td>3000.00</td>
</tr>
<tr>
<td>0</td>
<td>1522.0</td>
<td>0</td>
</tr>
<tr>
<td>300</td>
<td>1501.0</td>
<td>300</td>
</tr>
<tr>
<td>1200</td>
<td>1514.0</td>
<td>1200</td>
</tr>
<tr>
<td>2000</td>
<td>1496.0</td>
<td>2000</td>
</tr>
<tr>
<td>5000</td>
<td>1545.0</td>
<td>5000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>Sound Speed (m/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1522.0</td>
</tr>
<tr>
<td>300</td>
<td>1501.0</td>
</tr>
<tr>
<td>1200</td>
<td>1514.0</td>
</tr>
<tr>
<td>2000</td>
<td>1496.0</td>
</tr>
<tr>
<td>5000</td>
<td>1545.0</td>
</tr>
</tbody>
</table>
To create the Sound Profile user have to enter the profile name, Number of Station along radial and depth direction. Now in the next step if user needs to give range, set of Depth and Sound Speed in the corresponding place and press update to write in a TEXT file. Note that, the array of elements entered in the set of depth and sound speed will be of size \(1 \times \text{No. of depth direction} \). ‘Recreate’ will delete the old text file.

Fig. A31 Create Sound Speed Profile

Transmission Loss and Pressure can be calculated in a similar process as the analytical solutions and here the output file will be saved in the location ‘C:\Users\Amlan\Documents\MATLAB\COAT\Outputs\Single Ray Tracing’. The Bold part of the path will be changed according to your location where the complete package COAT is saved.

A 3.12 Shallow Acoustic Propagation

It will calculate the Penetration Depth and the stress mode for shallow acoustic propagation over a solid halfspace. The user have to enter the compressional wave speed in water, density of water and the solid, water depth, source frequency , Young Modulus and Poison Ratio of the solid medium. The code will calculates the compressional and distortional wave speed in solid layer. It
is recommended that choose $k_r$ increment very small such as $10^{-5}$. User can able to choose the type of plot such as stress mode, only $k_r$ plot. ‘Total No of roots’ gives the number of roots of the Eq. 9.48 in the range given in the Eq. 9.40. the pushbutton ‘Calculates ’ or ‘Plots’ evaluates numerically the Penetration Depth for maximum and minimum values of $k_r$. If penetration depth is 0 implies that the user need to change the computational depth (By default it is 1000 m). The user can change the default computational depth when the Penetration Depth becomes 0. By clicking ‘Plot Other Mode Shape’ the user can able to view the stress mode for desired mode.

![Shallow_Acoustic_Propagation_input_figure](image)

Fig. A32 Shallow Acoustic Propagation

The End

XXVII
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Created by :: Department of Ocean Engineering.

IIT Madras, Chennai 36.

Sponsored by :: National Institute of Technology (NIOT), Chennai