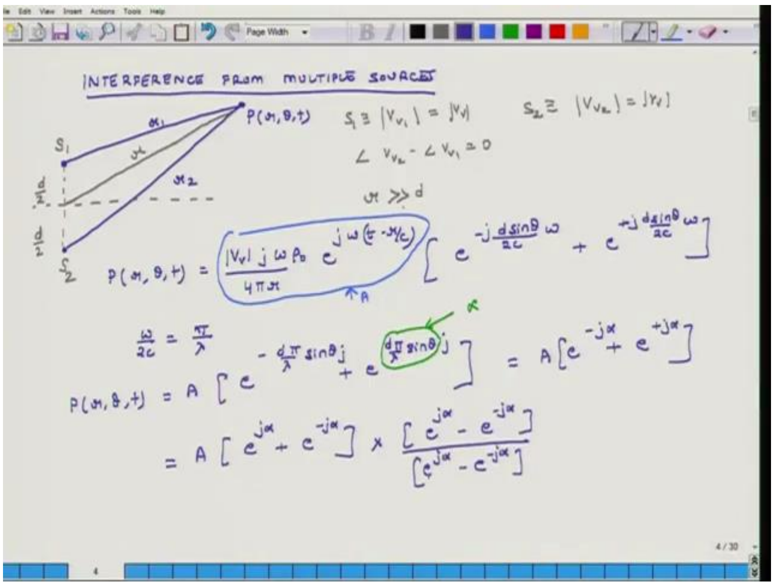
Fundamentals of Acoustics

Prof. Nachiketa Tiwari
Department of Mechanical Engineering
Indian Institute of Technology, Kanpur

Lecture – 38
Interference of Sound Sources – Part II

Hello, welcome to Fundamentals of Acoustics. Today is the second day of the 7th week of this course and what we plan to discuss is continue our discussion on interference pattern as the emitting from multiple sources. So, yesterday we had discussed, how sound waves constructively and destructively interferer, when there are 2 sources separated by some distance D. What we plan to do today is we will revisit that discussion with a somewhat simplified assumption with an additional assumption, and we will again develop the relation for two sources and then may be today as well as tomorrow and day after tomorrow we will develop relations for 4, 6 and finally n sources. And when we have n sources then using that information we will be able to figure out that suppose you have a string, and it is emitting some sound source, and if the string is vibrating uniformly at all points then what kind of sound patterns we can aspect. So, with that, we will start our discussion.

(Refer Slide Time: 01:23)



So, interference from multiple sources, so, supposes I have 2 sources; I will again start the discussion using 2 sources. So, that is r 1 that is r 2. I am interested in finding pressure at point P, which is distance r away. So, that is my median, this is my median line, the horizontal line, the distance from the median line, to point P is r, and this distance is D over 2, and this distance D over 2, the 2 sources are - S 1, S 2 and the volume velocity for S 1, is V v 1, and it is magnitude is such it is equal to V v.

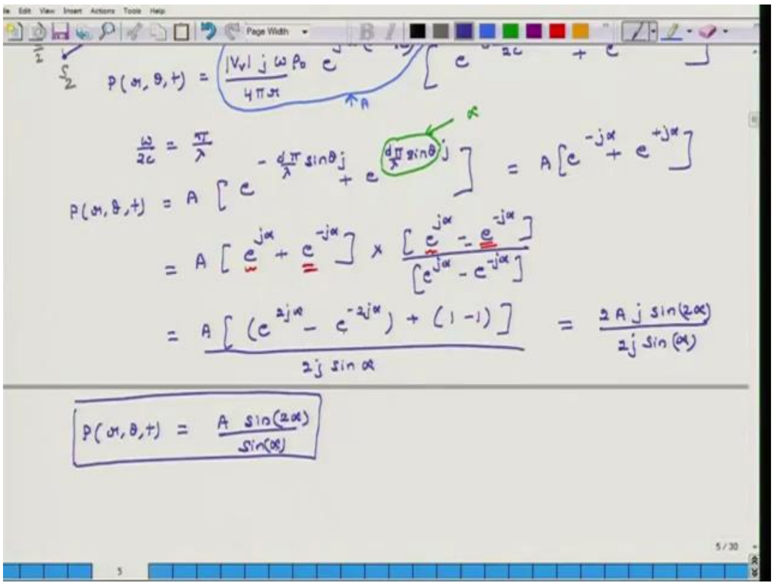
Similarly, for S 2 we have V v 2, and it is magnitude is equal to again V v. But here we make one additional assumption, which make things relatively simple, and that is the phase of V v 2 minus that of V v 1 is 0. So, earlier we had assumed that this V, but here it is 0. And the second thing is, r is still very large compared to the distance between 2 sources.

So, with that understanding, we will develop our expression one more time, and offer it in a somewhat different form it will be the same result or similar result. So, pressure at r theta t is equal to V v, times j omega rho naught divided by 4 pi r, e j omega t minus r over c, and in the brackets, in the brackets what we get is e minus j d sin theta divided by 2 c times omega, plus e plus j d sin theta divided by 2 c times omega. So, when the phase difference was c then they were also an e to the power of j phi in, both these terms, but that has gone away.

Now, we say that omega over 2 c, is equal to pi over lambda, and we call this entire expression as A. So, my pressure or complex pressure, equals A times exponent to the power of minus j, and omega over 2 c is pi over lambda. So, j d pi over lambda sin theta, plus e d pi over lambda sin theta, and then the of course, there is a j here and there is a j here.

Now, what we do is we define this thing as alpha. So, this is equal to A, e to the power of minus j alpha, plus e to the power plus j alpha. And the next thing is I take this expression, and in the parenthesis I have e to the power of j alpha, plus e to the power of minus j alpha, and then I do a mathematical operation on this. So, what is do is I multiply it by e to the power of j alpha, minus e to the power of minus j alpha, and I divided by the same thing e to the power of j alpha, minus e to the power of minus j alpha.

(Refer Slide Time: 06:57)



So, what do I get? In the numerator, what I get is, so when I multiply e to the power of j alpha by e to the power of j alpha, I get e to the power of 2 j alpha, I also get e to the power of minus 2 j alpha. So, this is one thing I get, and then when I multiply, e to the power of j alpha with this guy so I get 1, and when I multiply minus e to the power of minus j alpha, with e to the power of j alpha I get minus 1. And in the denominator, e to the power of j alpha minus, e to the power of minus j alpha is 2 j sin alpha. And the numerator becomes, 2 A j sin 2 alpha, and in the denominator I have 2j sin alpha; so p of r theta t. So, when I was doing this multiplication this thing should be a negative sign. Because, when I multiply this with this I get the first expression, and when I multiply this term with this term, I get the second expression and there is a negative sign here.

So, 2 j 2 j cancel out, and essentially I am left with A sin of 2 alpha divided by sin of alpha. So, if I have 2 sources my pressure at a far feel point is a times sin of 2 alpha divided by sin of alpha.

Thank you and have a great day, bye.