Computer Methods of Analysis of Offshore Structures
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Module - 02
Lecture - 10
Wind loads - 2

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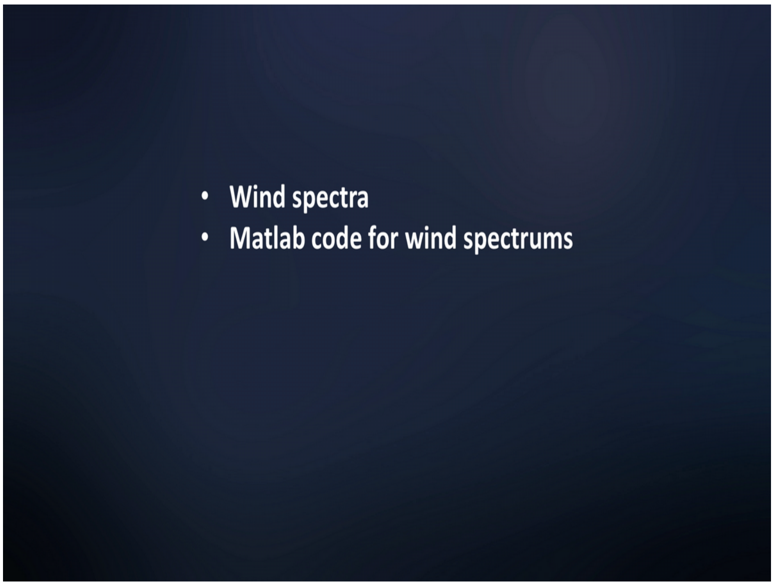

Friends, let us continue with the discussion on the wind loads lecture 10 on module 2. In the last lecture we said that wind force has got 2 components, the wind velocity has got here gust component and the mean wind component. We also said the spatial variation can be handled using aerodynamic admittance function, this alternative method of handling the gust component.

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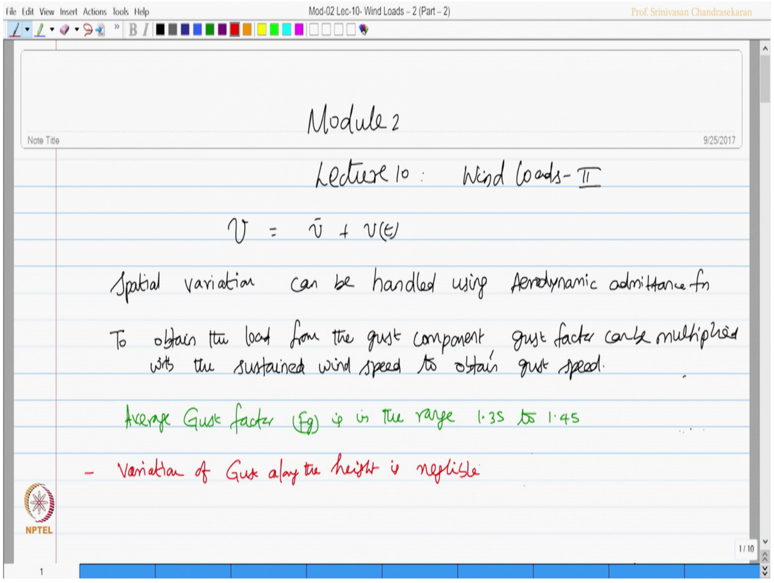

If one wants to obtain the load from the gust component, then one can use what is called as a gust factor with the sustained wind speed to obtain gust speed. Average gust factor addressed by the literature is in the range 1.35 to 1.45. Further variation of gust along the height is negligible, sustained wind speed should be used in the design of marine structures which is usually 1 minute average wind speed.

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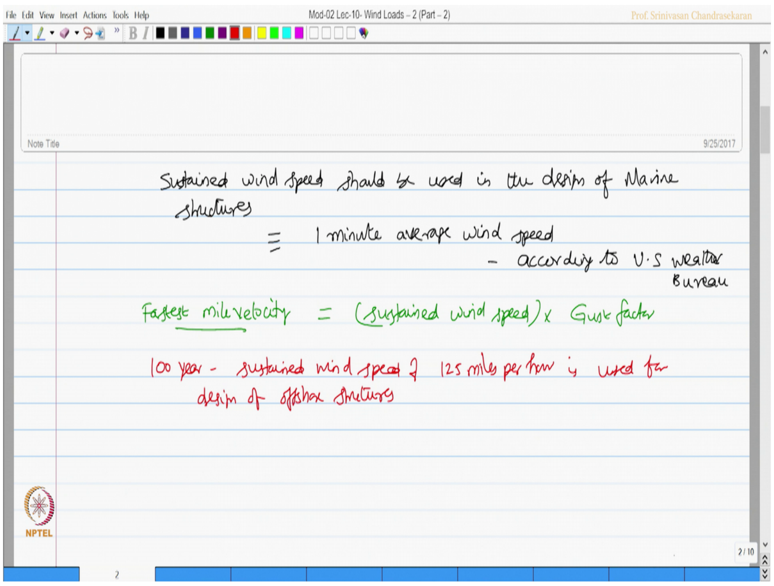

This is according to United States weather Bureau. Another term which is commonly used in the design that is called fastest mile velocity, this is actually equal to sustained wind speed multiplied by the gust factor. Further a 100 year sustained wind speed of 125 miles per hour is used for design of offshore structures.

Having said this let us see how wind velocity spectrum are available and discussed in the literature.

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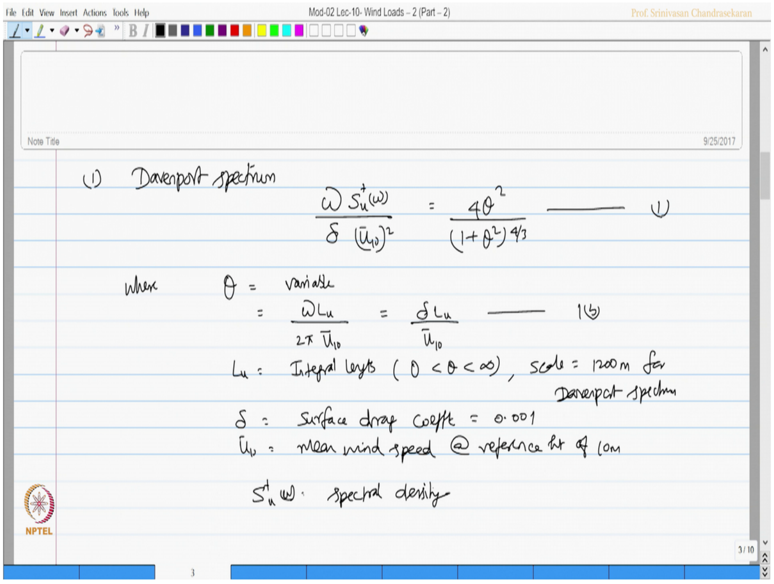

There is various spectra available for wind energy: Davenport spectrum which says omega S omega by del u bar 10 square is 4 theta square by 1 plus theta square 4 over 3 equation 1, where theta is the variable which is given by omega Lu by 2 pi U bar 10 which is also equal to del Lu by U bur 10 where Lu is called integral length, which is 0 less than infinity, for a scale of 1200 meters for Davenport spectrum. Del is called surface drag coefficient which is 0.001 U bar 10 is mean wind speed at reference height of 10 meters and of course, Su omega is the spectral density.

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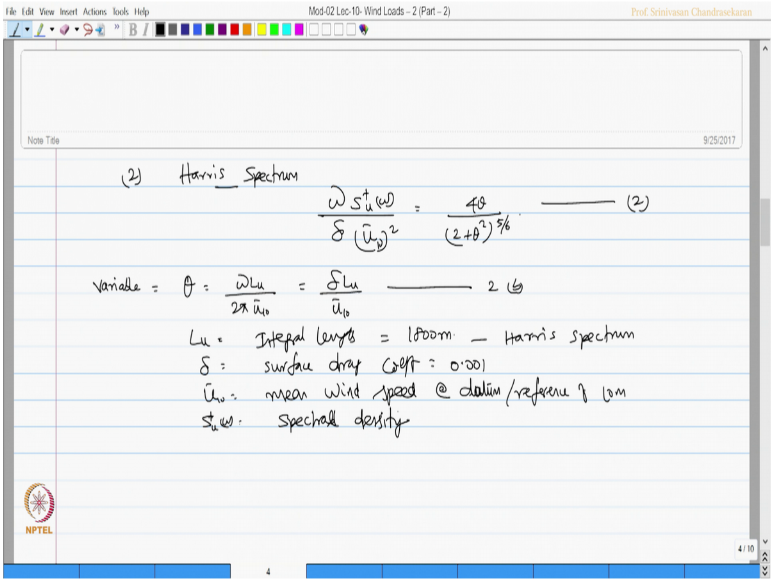

The second spectrum commonly used in design of marine structures is Harris spectrum, the equation is as given now I call this equation number 2, where in this case theta is again explained by the same which is practically same as the earlier equation, Lu theta is the variable Lu is again the integral length as usual, which is taken as 1800 meters for Harris spectrum and del is surface drag coefficient which is as same as 0.001, U bar 10 is mean wind speed at datum or reference height of 10 meters and S plus u is the spectral density.

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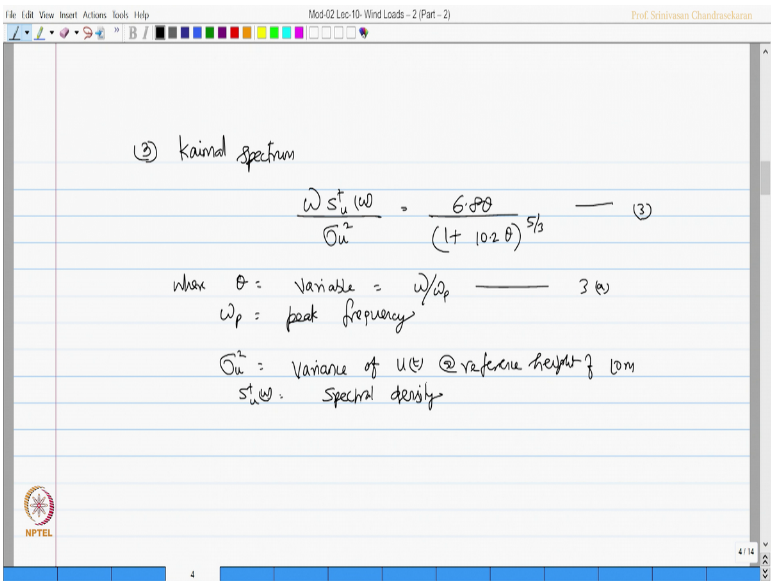

Next one is the Kaimal spectrum equation is as given now, where theta is the variable which is given by omega by omega p where omega p is the peak frequency, sigma u square is the variance of u of t at reference height of 10 meters and Su omega is the spectral density.

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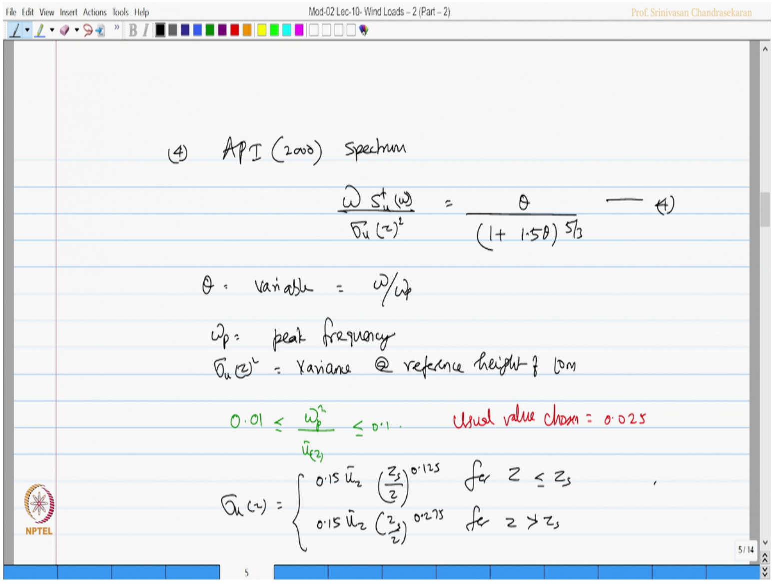

Next spectrum what we have in the literature is given by American petroleum institute API spectrum; the governing equation is now given in the screen. Again theta is the variable which is omega by omega p and omega p is the peak frequency; sigma uz square is again the variance at reference height of 10 meters.

So, there is a range within which you can select the ratio omega p square by u bar z, the usual value chosen is 0.025. Sigma uz is given by 0.15 U bar z zs by z to the power 0.125 for z less than z s 0.15 U bar z z s by z to the power 0.275 for z greater than zs.

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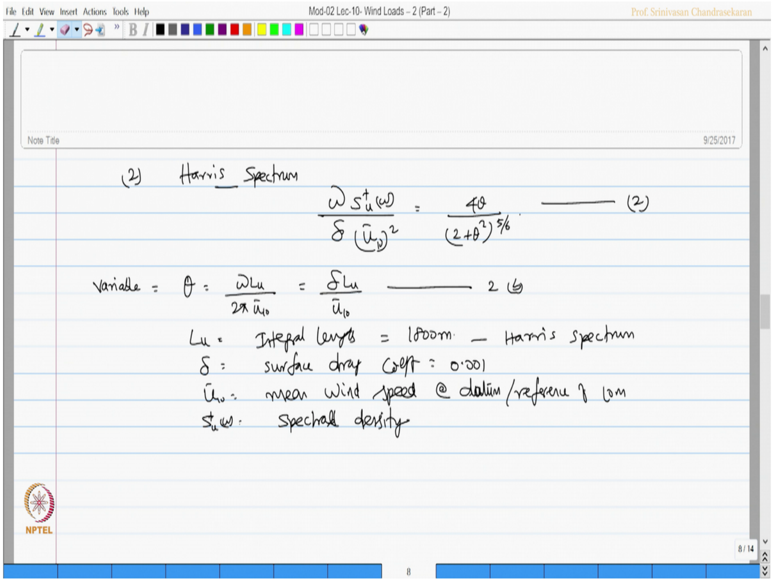

In this case Z s is called the surface height usually taken as 20 meters and z is a reference height usually taken as 10 meters and of course, S u omega is the spectral density.

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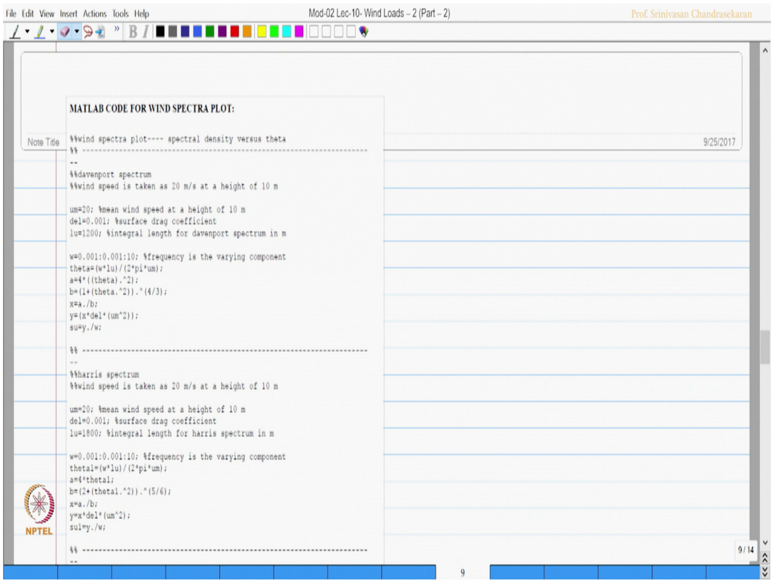

So, now we have a program which gives you the coding for plotting all this spectral plots. So, the coding helps you to plot the Davenport spectrum for a constant wind speed of 20 meter per second and the reference datum is 10 meter; so this coding available for Davenport, for Harris spectrum, for Kaimal spectrum, and for API spectrum.

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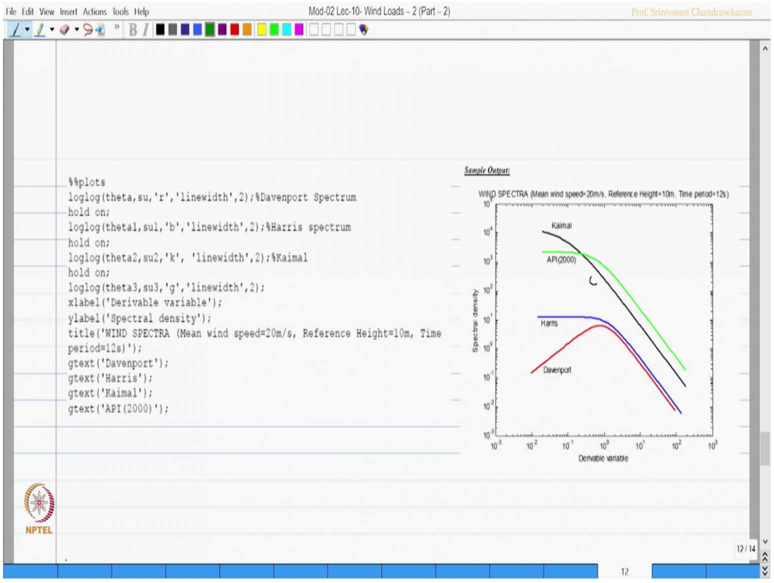

Then the plot actually gives you all the four davenport, Harris, Kaimal and API for a constant value of 20 meter per second and reference of 10 meter, the screen shows you all the plots comparable one can see the variation between all the expressions available on wind spectra like Davenport then Harris API and Kaimal.

So, the variation on the spectra or higher beyond a specific value of the variable which is theta, beyond that for a value more than the log scale of 10 power 0 or 1 something at this area. Beyond that the variation is minimal whereas, for a derivable variable theta lesser than one you will see that the spectrum values or spectral ordinates very distinctly vary for different values of the variable.

Having said this, now, one is interested to compute the force at any point z for the known wind velocity ok.

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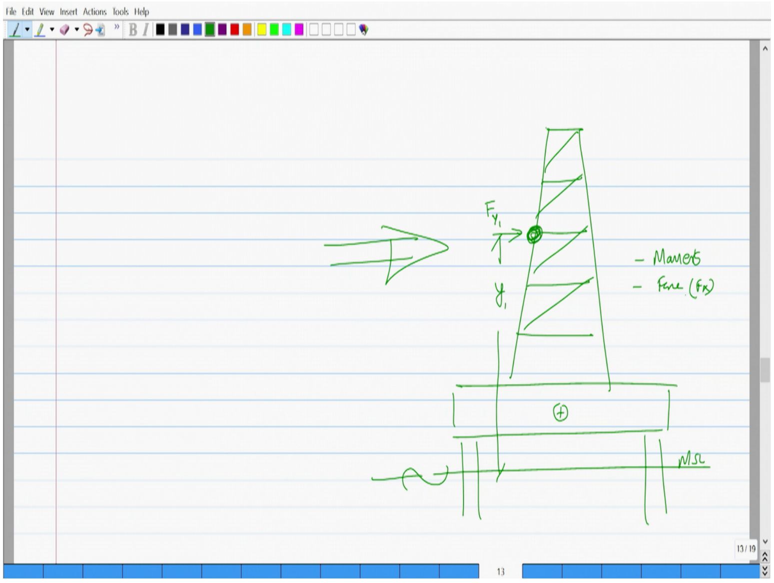

So, the question asked is I have any member may be any member which may be a drilling derrick is resting on the platform head of an offshore platform, which has got pontoon members etcetera this is my maybe my mean sea level.

So, the wind is blowing in this direction, I want know a specific point what is the wind force at this point y, where this is measured at a distance y or F y 1 and y one from the mean sea level this my mean sea level. By this logic by varying y 1 I can find forces at any point of my interest and keep on adding them or taking moments of these forces about the Cg I can find either the moments or I can find the force which is acting in the x direction.