Welcome, students to the first year course of basic Physics. in this module 24 will be covering production of ultrasonic waves from unit 3 acoustics.

In this module will be covering ultrasonic waves and methods of producing ultrasonic waves. By the end of this module will be able to list different methods of producing ultrasonic waves.

Now humans can perceive sound hearing range of frequencies from 20 Hertz to 20 kilohertz. This is the range of human audibility. The frequencies which humans can hear. Sounds of frequencies lower than 20 Hertz we call them infrasonic waves and sounds of frequencies higher than 20 kilohertz we call them ultrasonic waves. Both the frequencies in the Infrasonic range and the ultrasonic range we cannot hear. In this module will be mostly focusing on ultrasonic waves and methods of how to produce ultrasonic waves.

As said ultrasonic waves are high frequency waves, their frequency has to be above 20 kilohertz or they have high energy content since their frequency is high. The wavelength corresponding them is going to be low or small wavelengths. Just like any other sound waves ultrasonic waves get reflected, reflected, absorbed as usual. They can be transmitted over long distances with no appreciable loss in energy. Its also noticed that if we pass ultrasonic waves through a medium or a substance, it gets heated up. It shows some heating effect.

Now we look at three methods of producing ultrasonic waves in this module, them being Galton’s whistle, Magnetorestriction method and Piezoelectric crystal method.

The 1st method, which is called Galton’s whistle. It works on the principle of organ pipe. Now as you can see in the diagram, it has pipe closed at one end and open end of the pipe has a lip attached to it which I have marked. The distance between C&A can be adjusted with the help of the screw S1. Now to produce ultrasonic waves using Galton’s whistle what we do is we blast air through the nozzle. Once this air comes out of C It strikes the lip L and the lip oscillates.What will it do? The air surrounding lip starts vibrating will also move and that sets the entire air column into vibration. By adjusting the length and with the help of the piston, we can change the length of the air column A and we will set it to resonant position. In resonant position the frequency of vibration is going to be maximum. Since it uses the principle of organ pipe. So it's wavelength I can find. It's going to be 4 * L + X L being the length of the air column, and x being the end correction, so the frequency of sound which is produced is going to be the velocity of sound divided by 4 into L + X. Now using this method we can produce frequencies of up till 30 K Hz, which are not that high. The dog whistles which are used by dog trainers are also kind of Galton’s whistle. They produce sound waves of only about 30 kilohertz, not greater than that.

Now This next method we have is called magnetostriction method. It is based on the principle of magnetostriction effect. Now what the principle says is that if you have some ferromagnetic rod and it is subjected to alternating magnetic field you see that the bar tends to expand and contract in length alternately this effect is called magnetostriction effect. I'm just giving you a schematic diagram of the circuit. This is my nickel rod ferromagnetic rod I have a oscillator circuit over here. L1 and L2 are two inductors. I have a capacitor. OK, now this is all lately circuit

what it will be doing is once I switch on the circuit this rod is subjected to alternating magnetic field once it is subjected to alternating magnetic field. What you see happens? Is this the length of the rod expands and contracts which means over here the air is getting disturbed. An ultrasonic waves are produced at both the ends of this rod. With the help of the capacity here. OK, this variable capacitor I will adjust the value of capacitor such that the frequency of the circuit matches the natural frequency of the rod. I can check this with the help of a milliammeter when it shows maximum current, that will be addressing and condition. Using this method we can produce ultrasonic waves of up till 3 megahertz, so it's way better than Galton's whistle if we compare. Also, later I can produce higher frequency ultrasonic waves using magnetic restriction oscillator. Also the frequency of waves produces twice the frequency of the alternating magnetic field.

OK, the next method of producing ultrasonic waves is based on inverse piezoelectric effect. Now in inverse piezoelectric effect, if I take a certain quartz crystal and if I subject a pair of faces like I have in this diagram, we can see these two faces allowing this. I have the electrical axis and these two faces opposite faces is a mechanical axis. Now these two faces along the electrical axis. I subject them to alternating voltage and what I see is consequently the dimensions of the crystal change along the mechanical axis, which means it will. Again, it's length is going to change, alternating as the voltage is alternating, you will see compression and expansion of the crystal. The other two faces which are there. We employ this principle to create ultrasonic waves, so this is another order later circuit that we have OK between A&B you have a quartz crystal. Slide switches placed an what we see is are using this oscillator circuit will produce an alternating voltage across A&B. These faces of the quartz crystal that subjected to alternating electric field. So consequently what is going to happen? The other two faces they are lengths are going to change corresponding with the field and I will have ultrasonic waves produced here around the edges of the other two faces of the crystal. Now again this circuit. OK, I will see that it works at the resonant condition that will be when the frequency of oscillation of the alternating voltage is equal to its natural frequency of the quartz crystal. OK, that is done by varying this capacitor. Using piezoelectric oscillator we can produce ultrasonic waves of frequencies as high as 500 megahertz. Magnetostriction also later as we spoke it is quite efficient compared to Galton's Whistle. But piezoelectric oscillator is even more efficient than magnetostriction oscillator. The output is very high and also another thing that we notice is in magnetostriction oscillator the frequencies are dependent on temperature. If you use a piezoelectric oscillator, the frequencies produce are independent of temperature, so this is one of the best methods of producing high frequency ultrasonic waves. Thank you.