**EE307 Homework 1**

1. **Run 3 Matlab programs and describe your observation.**

Firstly, TM\_OPEN and TM\_BOX respectively show how the gaussian pulse of line source radiates and propagates in the open environment and the closed PEC square cylinder. In the open environment, the Gaussian pulse from the line source will spread out to infinity. But in the closed PEC square cylinder, the gaussian pulse of line source radiation bounce off the inside of the square cylinder and travel back and forth inside the square cylinder.

Then, TE\_HORN shows an animation of how E-plane sectoral (2-D) horn antennas radiate into an unbounded medium. The radiated pulse will be limited by the antenna shape of e-plane sector speaker before entering the unbounded medium and will spread in the whole space once entering the unbounded medium outside the E-plane sectoral horn antennas.

1. **Watch the video and write a 300 word** **synopsis**

This video mainly describes the working principle of antenna radiation electromagnetic wave and the judgment of electromagnetic wave propagation direction.

Although the antennas are vary in shape, their purpose is to emit or receive electromagnetic waves. We can start with a simple point source (point charge), which can be described as radiating energy in all directions, and the radiated energy can be expressed in terms of sinusoidal traveling waves. We can relate the wavelength of the radiation to the antenna from which the radiation is generated. To simplify the problem, we can model the antenna as a simple dipole at a distance of half the wavelength of the radiation. In the case of an antenna, if we send a signal with a certain period, there will be a flow of electrons in the antenna, which will be repeated in a periodic form (uniform distribution - concentrated on the left half - uniform distribution - concentrated on the right half). This flow of electrons also creates fluctuating magnetic fields, which are greatest when evenly distributed and whose direction changes twice in a period. The strength of this magnetic field is proportional to the amplitude of the current standing wave, which is 90 degrees out of phase with the voltage standing wave. For the voltage standing wave of an antenna, the direction of the voltage standing wave is different when the electron flow is concentrated in the left or right half. Of course, these constantly moving streams of electrons can also generate an electric field in a similar way, and the field is strongest when the stream is concentrated on the left or right side, but the field strength is in the opposite direction. Therefore, it can be seen from the above analysis that the phase difference between the electric field and magnetic field generated by the electron flow after the motion of the external signal is 90 degrees, which constitute the direct field of the antenna, and this direct field will produce the outward propagating waveform pattern. From an antenna, we can think of radiation as a series of orthogonal grids that are propagating outwards. These orthogonal networks of electromagnetic fields are electromagnetic waves that are propagating out. At the same time, the plane of the antenna is determined by the plane of the electric field. Both the transmitting antenna and the receiving antenna are in the same plane with the electric field. Finally, the video discusses the propagation direction of the transmitted electromagnetic waves: the propagation direction of such electromagnetic waves can be determined by a simple rule -- the pointing rule. In other words, given the direction of electric and magnetic fields, we can determine the direction of propagation of electromagnetic waves according to this rule. In the next time period, the direction of the electric field and magnetic field are opposite to the direction of the previous period, so the propagation direction of the electromagnetic wave remains the same, and the propagation direction of electromagnetic wave transmitted by the same antenna at any time is consistent. It is worth noting that when this electromagnetic wave reaches the surface of a reflecting plane, the direction of the magnetic field will remain the same, but the direction of the electric field will be the opposite of the previous direction. Therefore, by using the pointing rule, the electromagnetic wave travels in the opposite direction from the previous direction, which forms the reflected electromagnetic wave.

After watching this video combined with what I learned in class, I have a small question: It was mentioned in class that the dipole antenna can radiate periodic sinusoidal electric field waves. Combined with the figure in the PPT, we can see that the radiated electric field has a certain "distortion" when the dipole moves, so how is the irregular shape of the electric field formed?