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Faculty of Engineering
Department of Electrical and Electronics Engineering
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ANTENNA MODELLING

Preliminary Information :

Yagi-Uda Array Antenna : The Yagi-Uda is an array antenna consisting of linear elements. It is composed of a reflector, a driven element (feed), and one or more director elements (Figure 1). In Figure 1, from left to right, the first element is the reflector, the second is the driven element, and the subsequent elements are the directors.

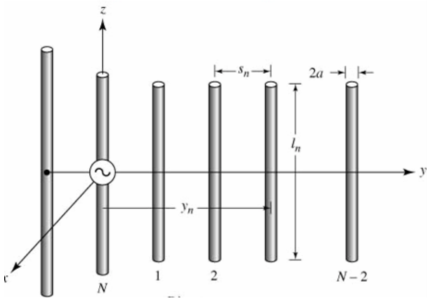


Figure 1: Diagram of a Yagi-Uda array

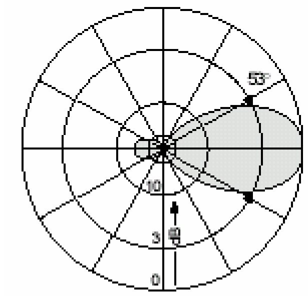


Figure 2: E-plane radiation pattern of a practical Yagi-Uda antenna (Kathrein K520721, 146-174 MHz)

It has a unidirectional radiation pattern (Figure 2), which consists of a main lobe, sidelobes, and a back lobe. It is used as a narrowband antenna in the HF (3-30 MHz), VHF (30-300 MHz), and UHF (300-3000 MHz) frequency bands. A properly designed 3-element antenna can achieve a gain of 7 dB. The front-to-back ratio is typically greater than 10 dB. Increasing the number of directors increases the gain, narrows the beamwidth, and lowers the feed-point impedance. It is commonly used as a VHF/UHF TV receiving antenna.

LPDA (Log-Periodic Dipole Array) Antenna : The LPDA is a wideband antenna with a unidirectional radiation pattern. Its gain is lower than that of a Yagi antenna with the same number of elements. The feed-point impedance is a logarithmic function of frequency. It is often used in HF, VHF/UHF for EMC/EMI measurements and as a TV receiving antenna. It is capable of exhibiting constant gain and input impedance over a wide frequency band. The element arrangement of an LPDA is shown in Figure 3, and a practical radiation pattern is given in Figure 4.

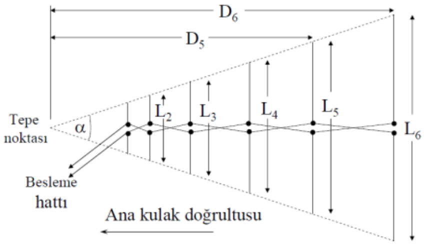


Figure 3: Structure of a Log-Periodic Dipole Array (LPDA) antenna.

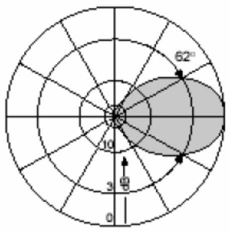


Figure 4: E-plane radiation pattern of a practical LPDA antenna.
(Kathrein K73232, 406-512 MHz)

AMS506 Antenna Modeling System : In this experiment, the Feedback AMS506 antenna modeling system, which operates in the 1200-1800 MHz range, will be used. The system includes transmitter-receiver units, computer software running in an MS-DOS environment, Yagi and LPDA arrays, and monopole antennas. Using this system, the frequency responses of antennas, the variation of return loss with frequency, radiation patterns at a desired frequency, and received signal levels can be examined. Figure 5 shows the frequency characteristic of an 8-element Yagi array with randomly arranged elements, Figure 6 shows its radiation pattern at 1460 MHz, and Figure 7 shows the variation of return loss with frequency.

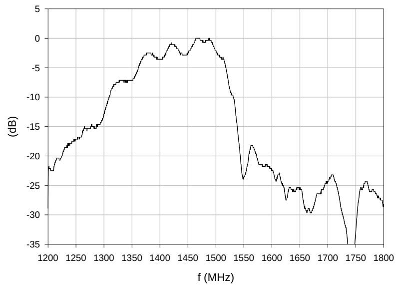


Figure 5

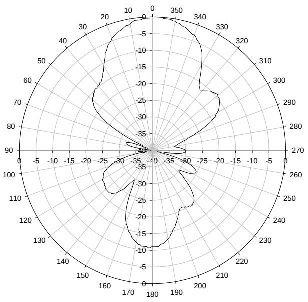


Figure 6

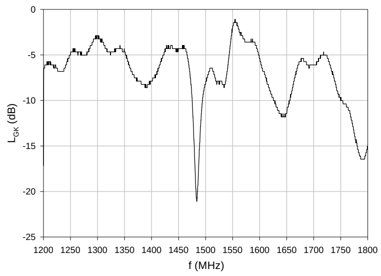


Figure 7

Experimental Procedure:

1. Sistemin Çalıştırılması

1.1. Turn on the computer on the desk and allow it to boot into the MS-DOS environment. The C:\> prompt will appear on the screen.

1.2. Type cd ant at the C:\> prompt and press ENTER. The prompt will change to C:\ant>.

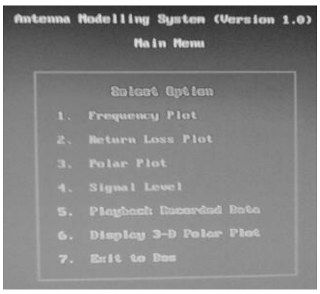
1.3. Type ant17 at the C:\ant> prompt and press ENTER. (This will run the Ant17 program and a series of prompts will appear.)

1.4. At the first prompt, type ?vga and press ENTER.

1.5. At the second prompt, first, turn the power switch of the transmitter unit (AMS506G) to the "1" position, then press the "y" key.

1.6. At the next prompt, type ?125 and press ENTER. The message "The motor enable switch must be on at this point" will appear. Set the "motor enable" switch on the transmitter unit to the "on" position.

1.7. Press ENTER to bypass the next prompt. The following program menu will be displayed on the screen.



You can start the experiment by making the appropriate selections from the main menu. After completing your work, turn off the "motor enable" and power switches on the transmitter unit first, and then turn off the computer.

2. LPDA Antenna
2.1 Frequency Response and Radiation Pattern

2.1.1 Place the two LPDA antenna arrays on the towers of the transmitter and receiver units, facing each other, and make the necessary connections.

2.1.2 From the program menu, select "1" for "Frequency Plot". The frequency response of the array in the 1.2-1.8 GHz range will be plotted. Analyze this graph and take notes. Identify the frequency corresponding to the highest signal level.

2.1.3 Return to the main menu. Select "3" for "Polar Plot". Plot the radiation pattern for the frequency you identified in step 2.1.2. On this pattern, identify and record the direction of maximum radiation, the 3-dB beamwidth, the main lobe width, the front-to-back ratio, and, if present, the level and direction of the largest sidelobe. The front-to-back ratio (F/B) is found as the difference between the value at $\theta=0$ (which should be 0 dB for a normalized pattern) and the value at $\theta=180$.

2.1.4 Plot the radiation patterns for several different frequencies on top of each other by pressing "S" each time. Observe the differences and take notes.

2.1.5 Return to the main menu. Select "4" for "Signal Level". For the frequency identified in step 2.1.2, record the signal levels in the forward direction ($\theta=0$) and the backward direction ($\theta=180$, for which you will need to rotate the antenna on the transmitter tower by 180^o). Calculate the F/B ratio in dB. Compare this with the value you found in step 2.1.3.

3. Yagi Antenna
3.1 Frequency Response and Radiation Pattern
3.1.1 Replace the LPDA antenna on the transmitter tower with the 8-element Yagi antenna.
3.1.2 Repeat the experimental steps 2.1.2 through 2.1.5 for the Yagi antenna..

Questions

1. From the patterns you have plotted, determine the half-power beamwidths for each antenna. Calculate the directivities of the antennas using the approximate formulas of Kraus and Tai & Pereira.
2. Do the radiation patterns you obtained match the expected patterns for these antennas? If not, explain the possible reason(s).