

EE 483/583 Antennas for Wireless Communications Quiz #6 (Spring 2026)Name KEYInstructions: Open homework. Place answers in indicated spaces and **show/circle** all work for credit.

A Yagi-Uda antenna is desired that will give a minimum directivity of 9 dBi and operate at 160.5 MHz. Design the **smallest** possible standard Yagi-Uda antenna that meets these specifications using a brass boom of diameter 3.736 cm and elements with diameters of 1.588 cm. Provide all indicated quantities (unitless, cm, or dBi). Sketch your design, including all relevant dimensions (cm) in the box. Assume boom extends 3 cm beyond center of last director and 27 cm beyond center of reflector. Assume $c = 2.998 \times 10^8$ m/s.

Design Steps:

1) Select or specify design parameters:

a. The directivity of a **3 element** Yagi-Uda antenna, from Table 10.6, is $7.1 \text{ dBd} = 7.1 + 2.15 = \mathbf{9.25 \text{ dBi}}$. [Note: For a Yagi-Uda antenna, gain \approx directivity.]

b. Design Frequency- $f = \mathbf{160.5 \text{ MHz}}$.

2) Select diameter d of elements and diameter D of metallic supporting boom

Given: Element diameter- $d = \mathbf{1.588 \text{ cm}}$ Boom diameter- $D = \mathbf{3.736 \text{ cm}}$

3) Calculate design wavelength λ . Use λ to calculate s_{12} (reflector-driven element spacing) & s_{23} [driven element-director] using Table 10.6 values.

$$\lambda = \frac{c}{f} = \frac{2.998 \times 10^8}{160.5 \times 10^6} = 1.867912773 \text{ m} \Rightarrow \lambda = \mathbf{186.7912773 \text{ cm}}$$

$$s_{12} = s_{23} = \mathbf{0.2\lambda} = \mathbf{0.2(186.76128)} \Rightarrow \mathbf{s_{12} = s_{23} = 37.35825545 \text{ cm}}$$

4) Calculate d/λ . Is $0.001 \leq d/\lambda \leq 0.04$?

$$d/\lambda = 1.588/186.77913 = \mathbf{0.0085} \Rightarrow \text{Within } 0.001 \leq d/\lambda \leq 0.04 \text{ range.}$$

5) If a metal boom is used, calculate D/λ . Is $0.001 \leq D/\lambda \leq 0.04$?

$$D/\lambda = 3.736/186.77913 = \mathbf{0.0200} \Rightarrow \text{Within } 0.001 \leq D/\lambda \leq 0.04 \text{ range.}$$

6) Since $d/\lambda = 0.0085$, go to step 11

$$\# \text{ of elements} = \mathbf{3} \quad \text{Directivity} = \mathbf{9.25 \text{ dBi}} \quad \lambda = \mathbf{186.79 \text{ cm}} \quad d/\lambda = \mathbf{0.0085}$$

$$D/\lambda = \mathbf{0.0200} \quad s_{12} = \mathbf{37.358 \text{ cm}} \quad s_{ij} = \mathbf{37.358 \text{ cm}}$$

11) The element lengths must be lengthened to compensate for a metal boom. On Figure 10.26, draw a vertical line from $D/\lambda = 0.02$ through the curve. Read

Boom compensation length = 0.0141λ

$$l_1 = 0.482\lambda + 0.0141\lambda = 0.4961\lambda = \boxed{92.6672 \text{ cm}}$$

$$l_3 = 0.442\lambda + 0.0141\lambda = 0.4561\lambda = \boxed{85.1955 \text{ cm}}$$

$$l_3 < l_2 < l_1$$

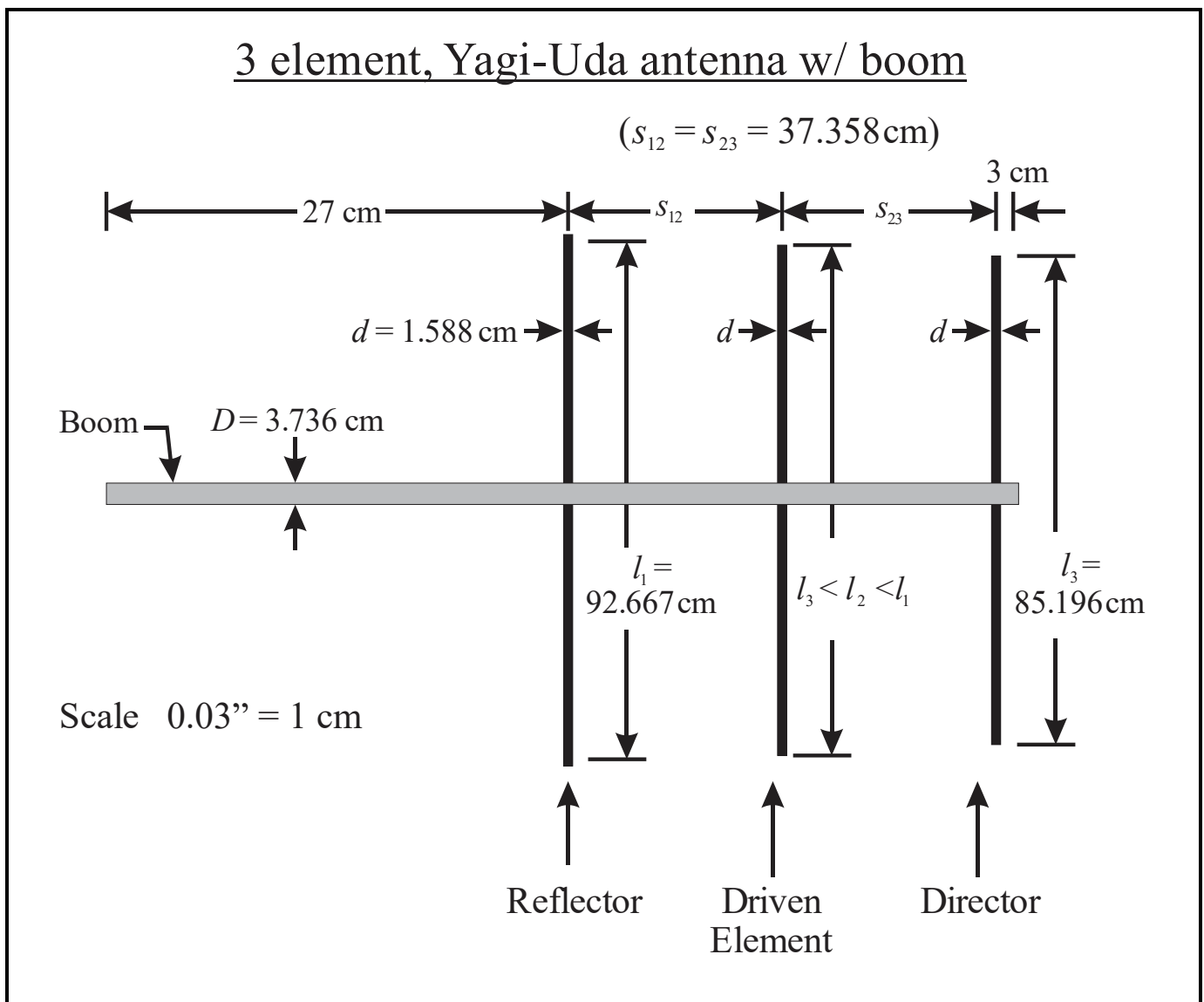


Table 10.6 OPTIMIZED UNCOMPENSATED LENGTHS OF PARASITIC ELEMENTS FOR YAGI-UDA ANTENNAS OF SIX DIFFERENT LENGTHS

$d/\lambda = 0.0085$ $s_{12} = 0.2\lambda$		LENGTH OF YAGI-UDA (IN WAVELENGTHS)					
		0.4	0.8	1.20	2.2	3.2	4.2
LENGTH OF REFLECTOR (l_1/λ)		0.482	0.482	0.482	0.482	0.482	0.475
LENGTH OF DIRECTORS, λ	l_3	0.442	0.428	0.428	0.432	0.428	0.424
	l_4		0.424	0.420	0.415	0.420	0.424
	l_5		0.428	0.420	0.407	0.407	0.420
	l_6			0.428	0.398	0.398	0.407
	l_7				0.390	0.394	0.403
	l_8				0.390	0.390	0.398
	l_9				0.390	0.386	0.394
	l_{10}				0.390	0.386	0.390
	l_{11}				0.398	0.386	0.390
	l_{12}				0.407	0.386	0.390
	l_{13}					0.386	0.390
	l_{14}					0.386	0.390
	l_{15}					0.386	0.390
	l_{16}					0.386	
	l_{17}					0.386	
SPACING BETWEEN DIRECTORS (s_{ij}/λ)		0.20	0.20	0.25	0.20	0.20	0.308
DIRECTIVITY RELATIVE TO HALF-WAVE DIPOLE (dB)		7.1	9.2	10.2	12.25	13.4	14.2
DESIGN CURVE (SEE FIGURE 10.25)		(A)	(B)	(B)	(C)	(B)	(D)

SOURCE: Peter P. Vezbicke, *Yagi Antenna Design*, NBS Technical Note 688, December 1976.

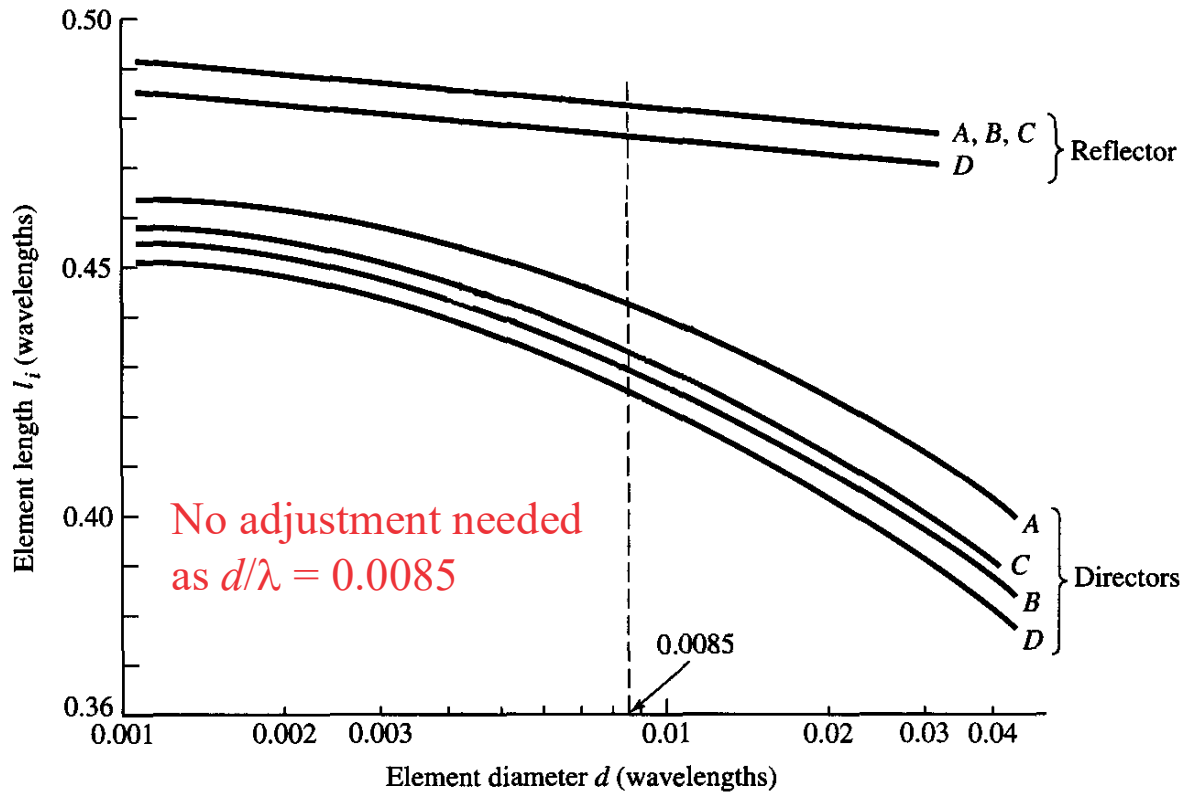


Figure 10.25 Design curves to determine element lengths of Yagi-Uda arrays. (SOURCE: P. P. Viezbicke, "Yagi Antenna Design," NBS Technical Note 688, U.S. Department of Commerce/National Bureau of Standards, December 1976)

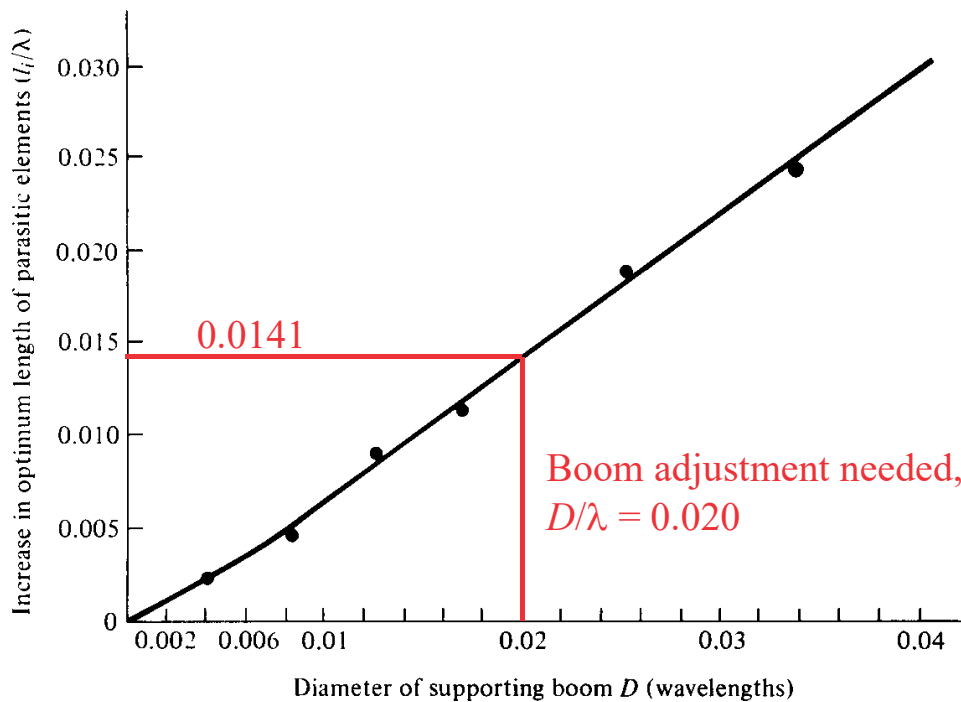


Figure 10.26 Increase in optimum length of parasitic elements as a function of metal boom diameter. (SOURCE: P. P. Viezbicke, "Yagi Antenna Design," NBS Technical Note 688, U.S. Department of Commerce/National Bureau of Standards, December 1976)