

$D =$ Spacing between adjacent elements $= \lambda/4$

$L =$ Total length of the array $= (n-1) d$

$$= (16-1) \frac{\lambda}{4} = 15 \frac{\lambda}{4}$$

(i) The Half Power Beam Width (HPBW) for the end fire array is given by

$$\text{HPBW} = 57.3 \sqrt{\frac{2}{l/\lambda}} \text{ degree}$$

$$\text{If } L = 15 \frac{\lambda}{4}, \text{ we get}$$

$$\text{HPBW} = 57.3 \sqrt{\frac{2}{\frac{15\lambda}{4 \times \frac{\lambda}{4}}}} = 41.84^\circ$$

(ii) The directivity for end fire array is given by

$$D = 4 \left[\frac{L}{\lambda} \right] = 4 \left[\frac{15\lambda}{\lambda} \right] = 15$$

The directivity can be expressed in decibel as

$$D(\text{in dB}) = 10 \log_{10} 15 = 11.76 \text{ dB}$$

(iii) Beam solid angle is given by

$$\psi/ = \frac{4\pi}{D} = \frac{4x\pi}{15} = 0.8377 \text{ Sr}$$

(iv) The effective aperture is given by

$$A_e = \frac{D\lambda^2}{4\pi} = \frac{15 \times \lambda}{4\pi} = 1.1936 \lambda^2 \text{ m}^2$$

TWO MARK QUESTION

1. What is meant by uniform linear array?

An array is linear when the elements of the array are spaced equally along the straight line. If the elements are fed with currents of equal magnitude and having a uniform progressive phase shift along the line, then it is called uniform linear array.

2. What is Broad side array?

Broad side array is defined as an arrangement in which the principal direction of radiation is perpendicular to the array axis and the plane containing the array element, For Broad side array. The phase difference between adjacent element is $=0$.

3. Define End fire array.

End fire array is defined as an arrangement in which the principal direction of radiation coincides with the array axis.

For end fire array $\alpha = \beta d$

Where $\beta = 2\pi/\lambda$

And $d =$ Distance between the elements

4. What is collinear array ?

In this array the antenna elements are arranged coaxially by mounting the elements end to end in straight line or stacking them one over the other with radiation pattern circular symmetry. E.g. Omni directional antenna.

5. What is Parasitic array?

In this array, the elements are fed parasitically to reduce the problem of feed line. The power is given to one element (driven element). The other elements get power by electromagnetic coupling. E.g. Yagi uda antenna.

6. What is the condition on phase for the end fire array with increased directivity?

When $\alpha = \beta d$, produces maximum field in the direction $\theta = 0$ but does not give the maximum directivity. It has been shown by Hansen and Wood yard that a large directivity is obtained by increasing the phase change between the sources so that $\alpha = -(\beta d + \pi n)$.

The condition will be referred to as condition for increased directivity.

7. Define array factor.

The normalized value of the total field is given by,

$$E = \frac{1}{n} \frac{\sin \frac{n\psi}{2}}{\sin \frac{\psi}{2}}$$

The field given by the expression E will be referred to as array factor.

8. Define beam width of major lobe.

It is defined as the angle between the first nulls (or) it is defined as twice the angle between the first null and the major lobe maximum direction.

9. Differentiate broad side and end fire array.

S.No	Broad side array	End fire array
1.	Antennas fed in phase $\alpha = 0$.	Antenna elements are fed out of phase $\alpha = -\beta d$
2.	Maximum radiation is perpendicular to the direction of array axis .	Maximum radiation is directed along the array axis.
3.	BWFN = $\frac{114.6}{l/\lambda}$	BWFN = $\pm 114.6 \sqrt{\frac{2}{l/\lambda}}$ degree
4.	Directivity = $2 \left[\frac{nd}{\lambda} \right] = 2 \left[\frac{L}{\lambda} \right]$	Directivity = $4 \left[\frac{L}{\lambda} \right]$

10. What is the need for the Binomial array?

The need for a binomial array is

- (i) In uniform linear array as the array length is increased to increase the directivity, the secondary lobes also occurs.
- (ii) For certain applications, it is highly desirable that secondary lobes should be eliminated completely or reduced to minimum desirable level compared to main lobes.

11. What is meant by similar point sources?

Whenever the variation of the amplitude and the phase of the field with respect to the absolute angle for any two sources are same then they are called similar point sources.

12. Define Beam width of major lobe.

It is defined as the angle between the first nulls (or) it is defined as twice the angle between the first null and major lobe maximum direction.

22. What is the principle of the pattern multiplication?

Similar point sources with equal maximum amplitudes are called identical point sources.

13. What is the principle of the pattern multiplication?

The total field pattern of an array of non- isotropic but similar sources is the product of the

- (i) Individual source pattern and
- (ii) The array pattern of isotropic point sources each located at the phase center of the individual source having the same amplitude and phase.

While the total phase pattern is the sum of the phase patterns of the individual source pattern and array pattern.

14. What is the advantage of pattern multiplication?

- ❖ Useful tool in designing antenna.
- ❖ It approximates the pattern of a complicated array without making lengthy computations.

15. What is a binomial array?

It is an array in which the amplitudes of the antenna elements in the array are arranged according to the coefficients of the binomial series.

16. What are the advantages and disadvantages of binomial array?

Advantage:

- ❖ **No minor lobes.**

Disadvantages:

- ❖ Increased beam width.
- ❖ Maintaining the large ratio of current amplitude in large arrays is difficult.

17. What is the difference between isotropic and non isotropic source?

- ❖ Isotropic source radiates energy in all directions but non- isotropic source radiates energy only in some desired directions.
- ❖ Isotropic source is not physically realizable but non –isotropic source is physically realizable.

18. Define Side Lobe Ratio.

Side Lobe Ratio is defined as the ratio of power density in the principal or main lobe to the power density of the longest minor lobe.

19. List the arrays used for array tapering.

- ❖ **Binomial Array:** Tapering follows the coefficient of binomial series.
- ❖ **Dolph Tchebycheff Array:** Tapering follows the coefficient of Tchebycheff polynomial.