Solution of Antenna & Radio TT355
Wave Propogation

Q.1: (a) Definition of polarization (2 m)
types of polarization (1 m)
Description of each (2 m)

(b) What is feed mechanism & (1m)
types
explanation of any one (4m)
with diagram.

(c) Antenna radiation mechanism (2m)
with expression (3m)

(d) Significance of each control (5m each)

(e) Complete derivation (5m)

Q.2 (a) Description of dipole (2 m)
fig 1 (field distribution) (2 m)
fig 2 (—11—) (2 m)
fig 2 (—11—) (2 m)

(b) Proper ~~[illegible]~~ sketch of pyramidal horn antenna (2m)
Explaination of horn (2 m)
Effect of aperture on radiation ~~pattern~~ with ~~pattern~~ (3m)
Effect of length of horn on radiation pattern (3m)

Q.3 (a) Proper diagram of Yagi-Uda antenna (2 m)
Explaination (2m)
Effect of length of each element on radiation pattern (3m)
Effect of spacing bet'n —11— (3m)

(b) Main diagram & equivalent diagram of folded dipole (3m)
Explaination of the same (2 m)
Derivation (5m)

Q.4 Complete derivation of Array factor with phasor diagram (7m)

Pattern multiplication (3m)

(b) Given $2m = 10$, $R_0 = 26$ dB

Soln:

(1) $(Af)_n = \sum_{n=1}^{m=5} a_n \cos[(2n-1)u]$ where $u = \frac{\pi d}{\lambda}\cos\theta$

(2) Expansion of $(Af)_n$ can be written as

$(Af)_{10} = a_1\cos(u) + a_2\cos(3u) + a_3\cos(5u) + a_4\cos(7u) + a_5\cos(9u)$

(3) $R_0 = 26$ dB $= 20\log_{10}(R_0)$

OR R_0 (Voltage ratio) $= 20$

(4) Determine z_0 by equating R_0 to $T_9(z_0)$

$R_0 = 20 = T_9(z_0) = \cosh[9\cosh^{-1}(z_0)]$

OR $z_0 = \cosh\left[\frac{1}{9}\cosh^{-1}(20)\right] = 1.0851$

(5) Substitute $\cos(u) = \frac{z}{z_0} = \frac{z}{1.0851}$ in (Af) found in step 2.

(6) Equate the Af of step 2, after the substitution from step 5 to $T_9(z)$,

$(AF)_{10} = z\left[(a_1 - 3a_2 + 5a_3 - 7a_4 + 9a_5)/z_0\right] + z^3\left[(4a_2 - 20a_3 + 56a_4 - 120a_5)/z_0^3\right]$

$+ z^5\left[(16a_3 - 112a_4 + 432a_5)/z_0^5\right] + z^7\left[(64a_4 - 576a_5)/z_0^7\right]$

$+ z^9\left[(256a_5)/z_0^9\right]$

$= 92 - 120z^3 + 432z^5 - 576z^7 + 256z^9$

(7) Matching similar terms allows the determination of the a_n's. i.e.

$256a_5/z_0^9 = 256$ $\Rightarrow a_5 = 2086$

$(64a_4 - 576a_5)/z_0^7 = -576$ $\Rightarrow a_4 = 2.8308$

$(26a_3 - 112a_4 + 432a_5)/z_0^5 = 432$ $\Rightarrow a_3 = 4.1184$

$(4a_2 - 20a_3 + 56a_4 - 120a_5)/z_0^3 = -120$ $\Rightarrow a_2 = 5.2073$

$(a_1 - 3a_2 + 5a_3 - 7a_4 + 9a_5)/z_0 = 9$ $\Rightarrow a_1 = 5.8377$

(8) In normalized form, the a_n coefficients can be written as

$a_5 = 1$
$a_4 = 2.357$
$a_3 = 1.974$
$a_2 = 2.496$
$a_1 = 2.748$

OR

$a_5 = 0.357$
$a_4 = 0.485$
$a_3 = 0.706$
$a_2 = 0.890$
$a_1 = 1$

(9) Using the first (left) set of normalized coefficients, the array factor can be written as

$$(AF)_{20} = 2.748\cos(\psi) + 2.496\cos(3\psi) + 1.974\cos(5\psi) + 1.357\cos(7\psi) + \cos(9\psi)$$

Q.5 (a) Given $f = 5.8\,GHz$, $\epsilon_r = 4.4$, $h = 1.6\,mm = 0.16\,cm$

Solⁿ:

Radius of patch

$$a = \frac{F}{\left\{1 + \frac{2h}{\pi\epsilon_r F}\left[\ln\left(\frac{\pi F}{2h}\right) + 1.7726\right]\right\}^{1/2}} = 0.525\,cm = 5.25\,mm$$

$$F = \frac{8.791 \times 10^9}{f_r\sqrt{\epsilon_r}} = 0.593$$

Q.5 (b) With diagram explanation of ionosphere propagation (7m)
Critical frequency (definition & expression) = $9\sqrt{N_m}$ (1½m)
Maximum usable frequency (— " —) = (sec i) f_c (1½m)

Q.6 (a) Block diagram of polarization measurement (2m)
Explanation (1m)
pattern sketches (2m)

(b) Explanation with dia (4m)
Expressions (1m)

(c) State different types & significance (2m)
Explanation of any one with diagram (3m)

(d) Explanation with functional diagram (3m)
Expressions of parameters with radiation pattern (2m)

(e) significance of near field & far field (2m)
explanation of each field with its range (3m)