EET 3422: ANTENNA THEORY & PRACTICE

CAT I

(a) A transmission line with a characteristic impedance of Z0=75Ω connects a signal generator to a load. However, due to an impedance mismatch, part of the signal is reflected toward the generator. (6 marks)

i. If the load's impedance is measured as ZL=150 Ω and the forward power delivered to the load is 200 W, calculate the reflection coefficient (Γ) at the load, the Voltage Standing Wave Ratio (VSWR), and the reflected power. What percentage of the total power is reflected due to the mismatch?

ii. To reduce losses, a matching network is designed to adjust the load impedance to ZL=75 Ω. With the matching network in place: Calculate the new reflection coefficient and VSWR. What is the reduction in reflected power after the network is installed?

(b) A transmitter provides 200 W of power to an antenna system with a transmission line of characteristic impedance Z_0=50 Ω. However, the impedance of the antenna is given by Z_A=40+j30 Ω. The antenna has a radiation resistance of Rr=35 Ω and an ohmic resistance Rl=5 Ω (4 marks)

i. Calculate the reflection coefficient Γ at the antenna.
ii. Find the power delivered to the antenna PA after accounting for reflection.
iii. Determine the antenna's efficiency, η and calculate the radiated power Prad.
iv. Assume an impedance matching network is used to perfectly match the antenna impedance to Z0. Calculate the new reflection coefficient and power delivered to the antenna.

(c) An antenna designed for a point-to-point communication system has a forward radiation power of 150 W and a backward radiation power of 5 W. The antenna operates at an efficiency of 85%. (5 Marks)

i. Calculate the F/B Ratio of the antenna in decibels (dB).
ii. If the power radiated in the forward direction is reduced to 130 W while maintaining the same backward power of 5 W, calculate the new F/B Ratio and the antenna gain in the forward direction. How does this reduction in forward power affect the overall antenna performance?

(d) A parabolic reflector antenna has a diameter of 3 meters and operates at a wavelength of 0.1 meters. (5 marks)

i. Calculate the gain (G) of the antenna if the efficiency factor (η) is 0.65.
ii. Determine the half-power beamwidth (HPBW) of the antenna and Explain how changing the diameter of the reflector affects the beamwidth.

(e) A narrowband antenna has a center frequency of 1 GHz and a relative bandwidth of 1%. (5 marks)

i. Calculate the absolute bandwidth of the antenna.
ii. Determine the highest and lowest frequencies that the antenna can effectively transmit or receive.

(f) An antenna has a radiation pattern that is described by the function $E(\theta) = 5\cos(\theta)$, where θ is the angle measured from the antenna's axis. (5 marks)

i. Sketch the radiation pattern of the antenna.
ii. Determine the half-power beamwidth (HPBW) of the antenna.