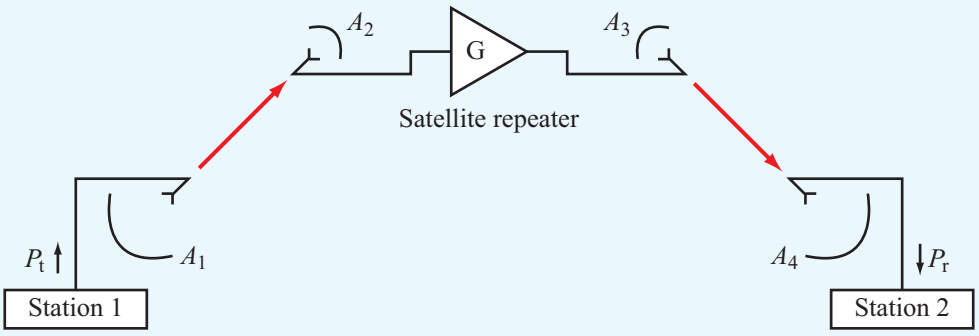

Figure P9.29 Satellite repeater system.

9.29 The configuration shown in Fig. P9.29 depicts a satellite repeater with two antennas, one pointed towards the antenna of ground station 1 and the other towards the antenna of ground station 2. All antennas are parabolic dishes, antennas A_1 and A_4 are each 4 m in diameter, antennas A_2 and A_3 are each 2 m in diameter, and the distance between the satellite and each of the ground stations is 40,000 km. Upon receiving the signal by its antenna A_2, the satellite transponder boosts the power gain by 80 dB and then retransmits the signal to A_4. The system operates at 10 GHz with $P_t = 1$ kW. Determine the received power P_r. Assume all antennas to be lossless.

Solution: Using Eq. (9.68) with $\xi_t = 1$, the power received by satellite antenna A_2 is

$$P_{r_1} = \frac{A_1 A_2 P_t}{\lambda^2 R^2} = \frac{4\pi \times \pi \times 10^3}{(3 \times 10^{-2})^2 \times (4 \times 10^7)^2} = 2.74 \times 10^{-8} \text{ W}.$$

The amplifier gain of 80 dB corresponds to a power ratio of 10^8. Hence, the power transmitted by satellite antenna A_3 is

$$P_{t_2} = 2.74 \times 10^{-8} \times 10^8 = 2.74 \text{ W}.$$

The power received by ground station antenna A_4 is:

$$P_r = \frac{A_3 A_4 P_{t_2}}{\lambda^2 R^2} = \frac{4\pi \times \pi \times 2.74}{(3 \times 10^{-2})^2 \times (4 \times 10^7)^2}$$
$$= 7.5 \times 10^{-11} \text{ W} = 75 \text{ pW}.$$