Remember to produce a clear homework document!
Explain your reasoning when going from one step to the next towards the final solution.

6. (a) Two Hertzian dipoles are located in the origin, the first one along the z axis and the other along the x axis. Their input currents have the same frequency and amplitude but they are in a phase shift of 90°: $\mathbf{a}_z I$ and $\mathrm{j}\mathbf{a}_x I$. Consider the electric far-field that these two elements together radiate. Determine the **polarization** of the radiated electric field in the following directions:

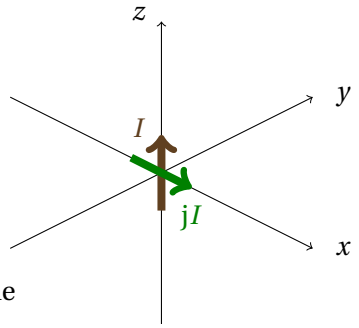
i. in the direction of the $+z$ axis

ii. in the direction of the $+x$ axis

iii. in the direction of the $+y$ axis

iv. in the direction of the $-y$ axis

v. in the direction $\theta = 45°$, $\phi = 0°$ in the zx plane



(b) The International Space Station ISS flies around Earth at the altitude of 360 km. To communicate to ground, there are several radio channels via satellites. However, it is also possible to have a direct radio link down from ISS.

Analyze the possibility of establishing radio communication using the amateur radio UHF channel at the frequency of 438 MHz. The UHF antenna on ISS has gain of 3 dB (rather small but the idea is to have a wide beam to cover broad areas on Earth—the station is not on a very high altitude, compared with Earth's radius 6370 km).

Assume a radio amateur located directly under ISS, who wants to transmit signal to the station. Her antenna has a gain of 13 dB and the transmitted power is 80 W.

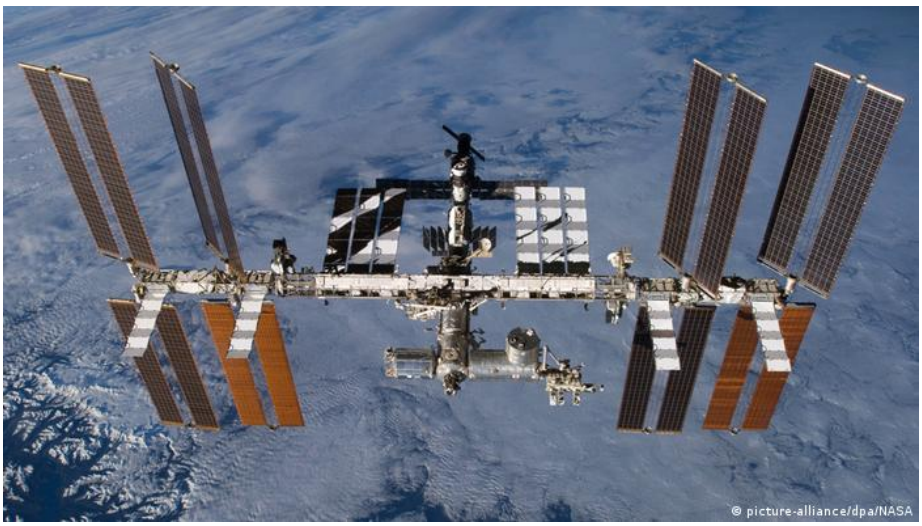
Calculate the received power at ISS.

(c) *(Continuing with the previous problem...)*

Imagine a hypothetical situation that a coaxial cable has been installed from Earth's surface up to ISS, and an electromagnetic signal is transmitted through this transmission line.

The highest-quality coaxial cables at UHF ranges can have attenuation which is as small as 1 dB per 100 meters.

Compute the attenuation of the signal from Earth to ISS through such a coaxial cable. How large would the received power be (assuming the same transmitted power of 80 W). Compare this number with your result in the previous problem for the free-space communication link.



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