7.18 Dry soil is characterized by $\varepsilon_r = 2.5$, $\mu_r = 1$, and $\sigma = 10^{-4}$ (S/m). At each of the following frequencies, determine if dry soil may be considered a good conductor, a quasi-conductor, or a low-loss dielectric, and then calculate α, β, λ, μ_p, and η_c:

(a) 60 Hz

(b) 1 kHz

(c) 1 MHz

(d) 1 GHz

Solution: $\varepsilon_r = 2.5$, $\mu_r = 1$, $\sigma = 10^{-4}$ S/m.

$f \rightarrow$	60 Hz	1 kHz	1 MHz	1 GHz
$\dfrac{\varepsilon''}{\varepsilon'} = \dfrac{\sigma}{\omega\varepsilon} = \dfrac{\sigma}{2\pi f \varepsilon_r \varepsilon_0}$	1.2×10^4	720	0.72	7.2×10^{-4}
Type of medium	Good conductor	Good conductor	Quasi-conductor	Low-loss dielectric
α (Np/m)	1.54×10^{-4}	6.28×10^{-4}	1.13×10^{-2}	1.19×10^{-2}
β (rad/m)	1.54×10^{-4}	6.28×10^{-4}	3.49×10^{-2}	33.14
λ (m)	4.08×10^4	10^4	180	0.19
u_p (m/s)	2.45×10^6	10^7	1.8×10^8	1.9×10^8
η_c (Ω)	$1.54(1+j)$	$6.28(1+j)$	$204.28 + j65.89$	238.27