Question bank - Rectangular Waveguide

1	For a 5 cm × 3 cm rectangular waveguide, the maximum peak electric field of the dominant mode at 5 GHz is 10 V/m. Find the maximum peak magnetic field inside the waveguide. Also find the total power carried by the waveguide.
2	For the fundamental mode inside a rectangular waveguide the logitudinal magnetic field is given as $$H_z = 20\cos(10y)e^{-j\beta z} A/m$$ Find the cut-off frequency of the mode. Also, find the frequency at which the group velocity is 1/3 of the phase velocity.
3	Inside an air-filled waveguide, the magnetic field component for a TM mode is given as $$\mathbf{H} = 10\cos(\pi x)\sin\left(\frac{\pi y}{2}\right)e^{-j\beta z}\hat{y}A/m$$ Find the vector electric field, the phase constant β and the cut off frequency of the wave. The frequency of the wave is 2 GHz.
4	Standard air-filled waveguides have been designed for the radar bands. One type, designed WG-16, is suitable for X-band applications. Its dimensions are, $a = 2.29$ cm and $b = 1.02$ cm. If it is desired that a WG=16 waveguide operate only in the dominant TE_{10} mode and that the operating frequency be at least 25 % above the cutoff frequency of the TE_{10} mode but no higher than 95 % of the next higher cutoff frequency, what is the allowable operating frequency range ?
5	A standard air-filled S-band rectangular waveguide has dimensions $a = 7.21$ cm and $b = 3.40$ cm. What mode types can be used to transmit electromagnetic waves having the following wavelengths? (**a**) $\lambda = 10$ cm (**b**)$\lambda = 5$ cm
6	An air-filled $a \times b$ $(b < a < 2b)$ rectangular waveguide to be constructed to operate at 3 GHz in the dominant mode. We desire the operating frequency to be at least 20 % higher than the cut off frequency of the dominant mode and also atleast 20 % below the cut off frequency of the next higher order mode. (**a**) Give a typical design for the dimensions a and b (**b**)Calculate for your design β, u_p, λ_g at the operating frequency (**c**)Define intrinsic impedance for TE mode. Calculate intrinsic impedance at the operating frequency
7	A resonant cavity of 6 cm × 3 cm × 4 cm is excited in the lowest mode. The peak electric field inside the cavity is 100 V/m. Find the resonant frequency of the cavity and the total energy stored inside the cavity.

8	A rectangular waveguide with dimensions $a = 2.5$ cm, $b = 1$ cm is to operate below 15.1 GHz. How many TE and TM modes can the waveguide transmit if the guide is filled with a medium characterized by $\sigma = 0$, $\varepsilon = 4\,\varepsilon_o$, $\mu_r = 1$? Calculate the cutoff frequencies of the modes.
9	An air-filled 5- by 2-cm waveguide has $$E_{zs} = 20 \sin 40\pi x \sin 50\pi y\, e^{-j\beta z} \text{ V/m}$$ at 15 GHz. (a) What mode is being propagated? (b) Find β. (c) Determine E_y/E_x.
10	In a rectangular waveguide for which $a = 1.5$ cm, $b = 0.8$ cm, $\sigma = 0$, $\mu = \mu_o$, and $\varepsilon = 4\varepsilon_o$, $$H_x = 2 \sin\left(\frac{\pi x}{a}\right) \cos\left(\frac{3\pi y}{b}\right) \sin(\pi \times 10^{11} t - \beta z) \text{ A/m}$$ Determine (a) The mode of operation (b) The cutoff frequency (c) The phase constant β (d) The propagation constant γ (e) The intrinsic wave impedance η.
11	A standard air-filled rectangular waveguide with dimensions $a = 8.636$ cm, $b = 4.318$ cm is fed by a 4-GHz carrier from a coaxial cable. Determine if a TE_{10} mode will be propagated. If so, calculate the phase velocity and the group velocity.
12	An air-filled rectangular waveguide of dimensions $a = 4$ cm, $b = 2$ cm transports energy in the dominant mode at a rate of 2 mW. If the frequency of operation is 10 GHz, determine the peak value of the electric field in the waveguide.
13	An air-filled resonant cavity with dimensions $a = 5$ cm, $b = 4$ cm, and $c = 10$ cm is made of copper ($\sigma_c = 5.8 \times 10^7$ mhos/m). Find (a) The five lowest order modes (b) The quality factor for TE_{101} mode