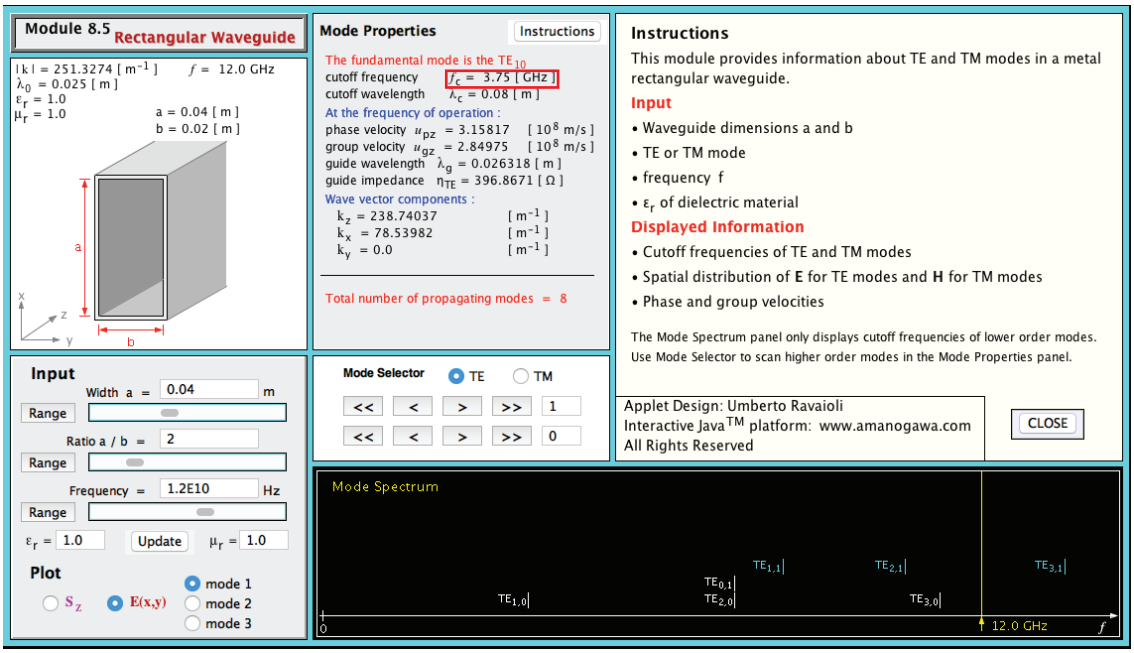
8.57 A hollow rectangular waveguide with dimensions $a = 4$ cm and $b = 2$ cm is used to propagate signals at 12 GHz. Use Module 8.5 to determine:

(a) The cutoff frequency of TE_{10} mode.

(b) All possible transmission modes.

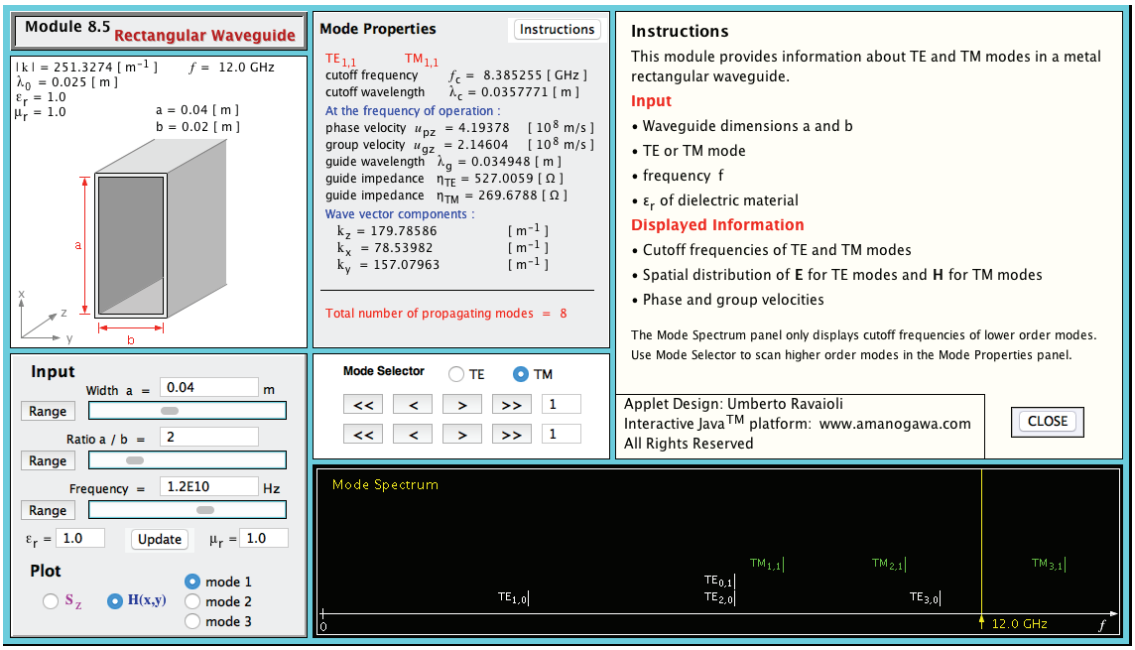
Solution: **(a)** According to Module 8.5,

$$f_c = 3.75 \text{ GHz for } TE_{10} \text{ mode.}$$



(b) Possible transmission modes include:

$$TE_{10}, TE_{01}, TE_{20}, TE_{11}, TE_{21}, TE_{30}, TM_{11}, TM_{21}.$$


Module 8.5 Rectangular Waveguide
|k| = 251.3274 [m⁻¹]
f = 12.0 GHz
λ0 = 0.025 [m]
εr = 1.0
μr = 1.0
a = 0.04 [m]
b = 0.02 [m]
a
b
x
z
y
Mode Properties
Instructions
TE1,1 TM1,1
cutoff frequency fc = 8.385255 [GHz]
cutoff wavelength λc = 0.0357771 [m]
At the frequency of operation :
phase velocity upz = 4.19378 [10^8 m/s]
group velocity ugz = 2.14604 [10^8 m/s]
guide wavelength λg = 0.034948 [m]
guide impedance ηTE = 527.0059 [Ω]
guide impedance ηTM = 269.6788 [Ω]
Wave vector components :
kz = 179.78586 [m⁻¹]
kx = 78.53982 [m⁻¹]
ky = 157.07963 [m⁻¹]
Total number of propagating modes = 8
Instructions
This module provides information about TE and TM modes in a metal rectangular waveguide.
Input
• Waveguide dimensions a and b
• TE or TM mode
• frequency f
• εr of dielectric material
Displayed Information
• Cutoff frequencies of TE and TM modes
• Spatial distribution of E for TE modes and H for TM modes
• Phase and group velocities
The Mode Spectrum panel only displays cutoff frequencies of lower order modes.
Use Mode Selector to scan higher order modes in the Mode Properties panel.
Input
Width a = 0.04 m
Range
Ratio a / b = 2
Range
Frequency = 1.2E10 Hz
Range
εr = 1.0
Update
μr = 1.0
Plot
Sz
H(x,y)
mode 1
mode 2
mode 3
Mode Selector
TE
TM
<< < > >> 1
<< < > >> 1
Applet Design: Umberto Ravaioli
Interactive Java™ platform: www.amanogawa.com
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CLOSE
Mode Spectrum
TM1,1
TM2,1
TM3,1
TE0,1
TE1,0
TE2,0
TE3,0
0
12.0 GHz
f