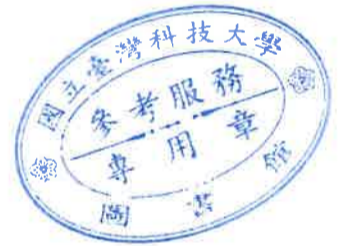
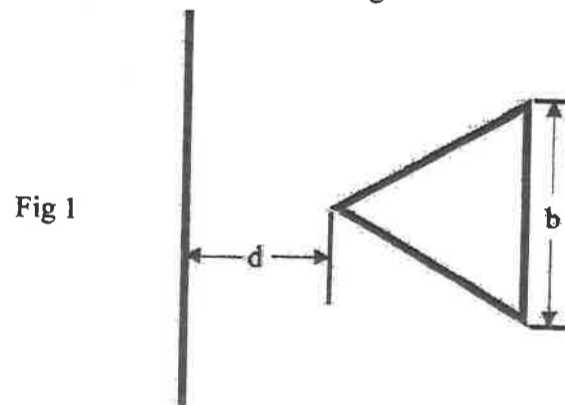


( 總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分 )

- If not explicitly mentioned, all values in the questions are in SI units
- For your reference:  $\epsilon_0 \approx 8.854 \times 10^{-12}$  [F/m],  $\mu_0 \approx 1.257 \times 10^{-6}$  [H/m],  $c_0 \approx 3 \times 10^8$  [m/s]

- (20%) Please write down the explicit expression for Laplace operator  $\nabla^2$  in
  - (10%) Cartesian coordinates
  - (10%) Cylindrical coordinates
- (15%) A positive charge  $Q$  is at the center of a spherical conducting shell of an inner radius  $a$  and an outer radius of  $b$ . Please derive  $V$  as functions of the radial distance  $R$  for  $R > b$ .
- (15%) Determine the mutual inductance between a very long, straight wire and a conducting equilateral triangular as shown in Fig 1



- (10%) Please derive the source-free wave equation of the electric field in free space from Maxwell's equations.
- (14%)
  - (10%) Please derive the instantaneous field of the  $TM_1$  mode in a lossless infinite parallel-plate waveguide sandwiched by two perfect conductors separating by distance of  $b$  as shown in Fig. 2. Let the permittivity and permeability of the medium be respectively  $\epsilon$  and  $\mu$ . Assume the harmonic wave (with angular frequency  $\omega$ ) propagates towards (+z) direction, the initial phase is 0, and the amplitude of  $E_z$  is 1.  $(E_x, E_y, E_z, H_x, H_y, H_z) = ( \dots )$ ?
  - (4%) Is  $TM_1$  a TEM wave?

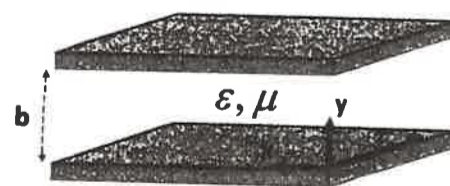


Fig.2

國立臺灣科技大學 112 學年度碩士班招生試題  
系所組別：電子工程系碩士班丙組  
科目：電磁學

( 總分為 100 分；所有試題務必於答案卷內頁依序作答，否則不予計分 )

6. The propagation constant of a narrow-band signal is  $j\frac{\omega}{2 \cdot 10^8} \sqrt{1 - \left(\frac{6.28 \cdot 10^7}{\omega}\right)^2}$ , where  $\omega$  is the angular frequency of the carrier. If the carrier frequency is 20 [MHz], please answer: (16%)
- (1) (4%) What is the cutoff frequency?
  - (2) (4%) What is the phase velocity of the signal?
  - (3) (4%) What is the group velocity of the signal?
  - (4) (4%) Explain whether the medium is dispersive or not.
7. A sine wave is traveling through a medium with a skin depth of 0.1 mm. Please answer: (10%)
- (1) (5%) Explain the meaning of "skin depth."
  - (2) (5%) At what traveling distance from the medium boundary, will the wave be attenuated by 3-dB?

