國立中山大學110學年度
碩士暨碩士專班招生考試試題

科目名稱：電磁學【光電系碩士班】

—作答注意事項—

考試時間：100分鐘

- **考試開始鈴響前不得翻閱試題，並不得書寫、劃記、作答。**請先檢查答案卷（卡）之應考證號碼、桌角號碼、應試科目是否正確，如有不同立即請監試人員處理。
- **答案卷限用藍、黑色筆(含鉛筆)書寫、繪圖或標示**，可攜帶橡皮擦、無色透明無文字墊板、尺規、修正液（帶）、手錶(未附計算器者)。每人每節限使用一份答案卷，不得另攜帶紙張，請衡酌作答。
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國立中山大學 110 學年度碩士暨碩士專班招生考試試題

科目名稱：電磁學【光電系碩士班】　　題號：435002

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　

1. (16%) Please derive the boundary conditions for static **D** and **H** across an interface of two media.
2. (20%) A parallel-plate capacitor of 5 m^2 area and plate separation of 12 mm is filled with three dielectric slabs of equal thickness as shown in Fig. 1. If a potential of 120 V is applied to the capacitor, neglect the fringing and find out: (a) polarization **P** in each region (10%) and (b) capacitance C of the capacitor (10%).

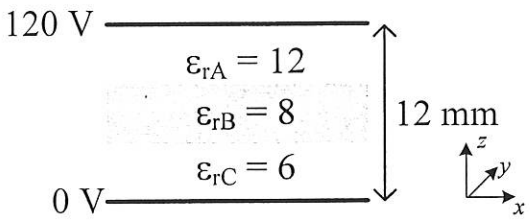


Fig. 1

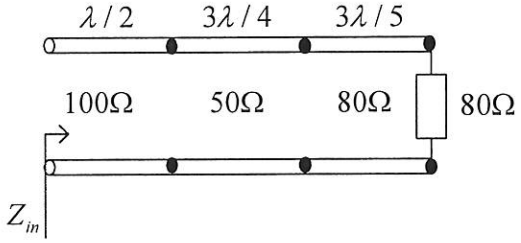
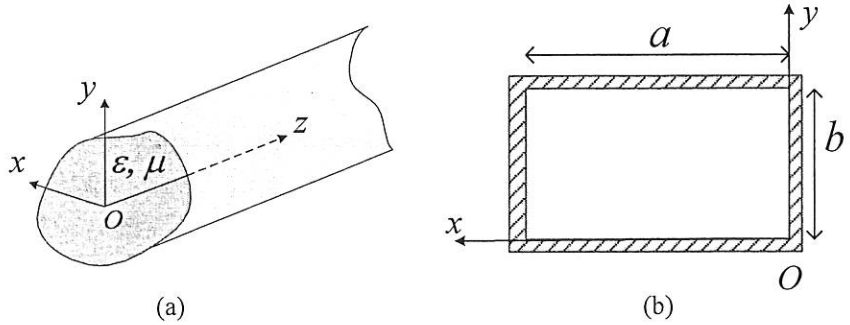


Fig. 2

3. (20%) For time-harmonic fields, please answer the following questions:
   (a) Write down the Maxwell's equations in phasor form. (12%)
   (b) In a simple and nonconducting source-free medium, please derive the homogenous vector Helmholtz's equation for **H**. (8%)
4. (16%) In free space, a uniform plane wave is expressed as:

$$\mathbf{E} = (\mathbf{a}_x j3 + \mathbf{a}_y 3 - \mathbf{a}_z 4) \cdot e^{-j(1.6\pi y + k_z z)}$$

   (a) What is the value of k_z ? (4%)
   (b) What is the corresponding **H** field? (6%)
   (c) Please find out the time-average power flow per unit area normal to the direction of propagation. (6%)
5. (8%) For a transmission line system shown in Fig. 2, please find out the input impedance Z_{in}.
6. (20%) Consider uniform waveguide structures and answer the following questions:
   (a) For a uniform waveguide with arbitrary cross section as shown in Fig. 3(a), please derive the two-dimensional (2-D) vector phasor expression of transverse magnetic field components in terms of $E_z^0(x,y)$ and $H_z^0(x,y)$, where $E_z^0(x,y)$ and $H_z^0(x,y)$ are 2-D vector phasors for E_z and H_z. (10%)
   (b) For an air-filled metallic rectangular waveguide with the transverse dimensions a = 5.0cm and b = 3.0cm as shown in Fig. 3(b), if the operation wavelength is λ = 5.0cm, find out the modes which can appear on this waveguide. (10%)



(a)　　(b)

Fig. 3

國立中山大學110學年度
碩士暨碩士專班招生考試試題

科目名稱：工程數學【光電系碩士班】

－作答注意事項－

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國立中山大學 [redacted] 學年度碩士暨碩士專班招生考試試題

科目名稱：工程數學【光電系碩士班】　　題號：435001

※本科目依簡章規定「可以」使用計算機（廠牌、功能不拘）（問答申論題）　　共 1 頁第 1 頁

1. (a) (10%) Let **A** be a square matrix of order n and **A** is normal. w is an arbitrary non-zero $1 \times n$ column vector, proof that

$$\lim_{k\to\infty} \frac{w^{\mathrm{T}} \cdot (\mathbf{A}^{k+1} w)}{w^{\mathrm{T}} \cdot (\mathbf{A}^{k} w)} \approx \lambda_1$$

λ_1 is the largest eigenvalue corresponding to eigenvector $u = \lim_{k\to\infty} u_k$ where

$$\lim_{k\to\infty} u_k \equiv \lim_{k\to\infty} \mathbf{A}^k w.$$

(b) (10%) Let λ_2 is an eigenvalue of A such that $|\lambda_2 - \lambda_1| > |\lambda_p - \lambda_1|$ where λ_p is any eigenvalue of **A** other than λ_2 and λ_1. Describe a method to find λ_2 and its associated eigenvector and prove that method in details.

2. (a) (10%) Calculate the Fourier transform of the function,

$$f(t) = e^{-|t|}$$

You are supposed to show detailed calculations.

(b) (10%) Solve y from the differential equation under the condition that $y(\pm\infty) = 0$

$$y - \frac{\mathrm{d}^2 y}{\mathrm{d}t^2} = e^{-x^2}$$

3. (20%) Three particles of identical mass m are connected by springs and attached to non-moving walls as shown in Fig. 1. All the springs are identical and have a spring constant k. The forces exerted on particles obey hooks law. Gravitation is neglected. Find the equation of motion for the three particles deviating from their equilibrium positions (x_1, x_2, x_3 in Fig. 1), respectively and find the eigenfunctions and corresponding eigenvalues of the oscillator system.

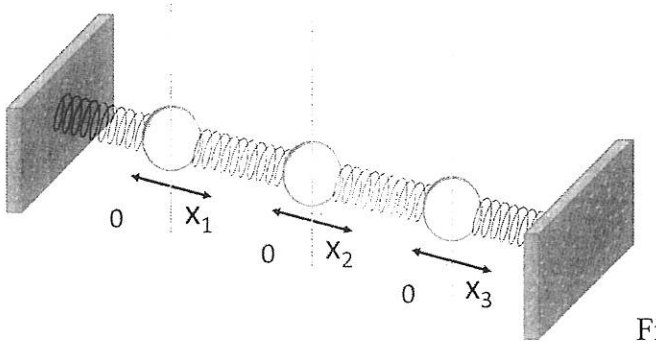

Fig. 1

4.(a) (10%) Evaluate the integral

$$\int_{-\infty}^{\infty} e^{i\pi t^2} dt$$

(b) (10%) Evaluate the Fourier transform of the chirp functions, $f(t) = e^{i\pi t^2}$.

5. (20%) Solve coupled differential equations,

$$\begin{cases} \dfrac{dJ_1}{dz} = \dfrac{g_0 J_1}{1 + J_1 + J_2} \\ \dfrac{dJ_2}{dz} = \dfrac{-g_0 J_2}{1 + J_1 + J_2} \end{cases},$$

subjected to the constraints $J_1(z)$ and $J_2(z)$ represent positive flow quantity in the domain $z \in (0, L)$, g_0 is a positive constant. The following boundary conditions are also enforced,

$$J_2(0) = RJ_1(0)$$

$$J_1(L) = RJ_2(L)$$

試題請隨卷繳回，請留意背面是否有題