

國立交通大學 99 學年度碩士班考試入學試題

科目：電磁學(1502)

考試日期：99 年 3 月 14 日 第 2 節

系所班別：光電、顯示聯招

組別：光顯聯招

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【不可使用計算機】*作答前請先核對試題、答案卷(試卷)與准考證之所組別與考科是否相符!!

1. (15%) Show that
 - a). (5%) $\nabla \times \nabla V = 0$
 - b). (5%) $\nabla \cdot (\nabla \times \vec{A}) = 0$
 - c). (5%) $\nabla \psi \triangleq \lim_{\Delta V \rightarrow 0} \frac{\int \psi d\vec{S}}{\int dV}$
2. (20%) please
 - a). (10%) Find the energy required to assemble a uniform sphere charge of radius b and volume charge density
 - b). (10%) Einstein's theory of relativity stipulates that the work required to assemble a charge is stored as energy in mass and is equal to mc^2 . Assuming the electron to be perfect sphere, find the radius from its charge and mass $\left\{ \epsilon_0 = \frac{1}{36\pi} \times 10^{-9} \left(\frac{F}{m} \right), e = 1.602 \times 10^{-19} (C), m_e = 9.107 \times 10^{-31} (kg) \right\}$
3. (20%) A 60-MHz plane wave traveling in the $-x$ direction in a medium with relative permittivity $\epsilon_r = 4$ has an electric field polarized along the $+z$ direction. Assuming the medium is approximately lossless, and given that the magnetic field has a peak value of 10 (mA/m) and that its value was measured to be 10 (mA/m) at $t = 0$ and $x = -0.75m$, develop complete expressions (in function of cosine) for the
 - (a) electric, $\vec{E}(x, t)$ field (5%)
 - (b) magnetic, $\vec{H}(x, t)$ field (5%)
 - (c) the phase velocity of the plane wave (10%)
4. (15%) In a microwave oven, a sinusoidal electric intensity of amplitude of 200 (V/m) and frequency of 2.4 GHz is irradiated to cook a meat, which has a relative permittivity of 40 and a loss tangent of 0.35 at the frequency of 2.4 GHz. Given the permittivity of free space is $(1/36\pi \times 10^{-9})$. Please calculate
 - (a) the effective conductivity of the meat (5%)
 - (b) the average power dissipated per unit volume (10%)
5. (15%) A diameter=2.2cm air-filled circular waveguide is operating at 11GHz
 - (a) (5%) What is the cutoff frequency of the dominated mode?
 - (b) (5%) How many modes can be propagated in the wave guide?
 - (c) (5%) What are those modes?

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Zeros of $J_n(x)$, x_{np}

$p \backslash n$	$n=0$	$n=1$	$n=2$
1	2.405	3.832	5.136
2	5.520	7.016	8.417

Zeros of $J'_n(x)$, x'_{np}

$p \backslash n$	$n=0$	$n=1$	$n=2$
1	3.832	1.841	3.054
2	7.016	5.331	6.706

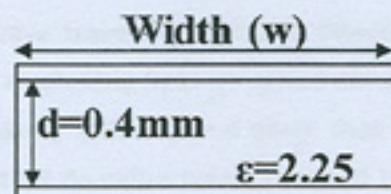
6. 單選題，每題 3 分，答錯倒扣 1 分

(a). What kind of transmission line is usually operated at microwave frequency, used on printed circuit board, and also called strip line?

[1] Parallel-plate, [2] Two wire, [3] Coaxial transmission line.

(b) Neglecting losses and fringe effects and assuming the substrate of a transmission line to have a thickness 0.4(mm), a dielectric constant 2.25, and a characteristic resistance of 50Ω . What is the required width(w) of the transmission line?

[1] 1mm, [2] 2mm, [3] 3mm, [4] 4mm.



(c) What is the characteristic of "Distortion-less ($\frac{R}{L} = \frac{G}{C}$)" transmission line?

- [1] Same frequency (ω), same attenuation (α) of different wave velocity (v)
- [2] Same wave velocity (v), same frequency (ω) of different attenuation (α)
- [3] Same wave velocity (v), same attenuation (α) of different frequency (ω)

(d) The radiation resistance R_r (a hypothetical resistance) of an antenna was used to evaluate the radiation efficiency ($P_r = \frac{1}{2} I R_r^2$). With [1] larger or [2] smaller radiation resistance R_r , means a better Antenna?

(e) A single unit of an Antenna is half-wave ($\frac{1}{2}\lambda$) dipole. However, the directivity of a $\frac{1}{2}\lambda$ dipole is not good enough. How to increase the directivity of an Antenna?

- [1] Change to a $\frac{1}{4}\lambda$ dipole.
- [2] Change to two $\frac{1}{4}\lambda$ dipole array.
- [3] Change to two $\frac{1}{2}\lambda$ dipole array.
- [4] Change to a full-wave (λ) dipole.