單選題，共二十題，每題5分。

1.(5%) A circular disk of radius a is uniformly charged with ρ_s C/m^2. If the disk lies on the z=0 plane with its axis along the z-axis, What is the electric field that at point $(0, 0, h)$?

(A) $\vec{E} = \frac{\rho_s}{\varepsilon_0}\left[\frac{h}{(h^2+a^2)^{\frac{1}{2}}}\right]\hat{a}_z$

(B) $\vec{E} = \frac{\rho_s}{\varepsilon_0}\left[1 - \frac{h^2}{(h^2+a^2)}\right]\hat{a}_z$

(C) $\vec{E} = \frac{\rho_s}{2\varepsilon_0}\left[\frac{h^2}{(h^2+a^2)}\right]\hat{a}_z$

(D) $\vec{E} = \frac{\rho_s}{2\varepsilon_0}\left[1 - \frac{h}{(h^2+a^2)^{1/2}}\right]\hat{a}_z$

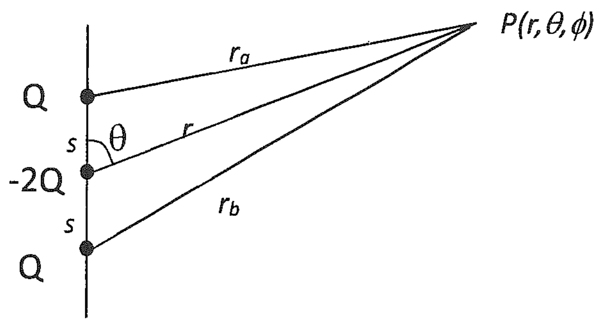
2.(5%) The linear electric quadrupole is a set of three charges as shown in the following figure. The separation s is again much smaller than the distance r to the point P. What is the potential V at the point of P:

(A) $V = \frac{Qs}{4\pi\varepsilon_0 r^2}\frac{(3\cos^2\theta-1)}{2}$

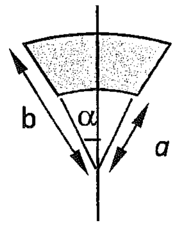
(B) $V = \frac{Qs^2(3\cos^2\theta-1)}{4\pi\varepsilon_0 r^3}$

(C) $V = \frac{2Qs^2(3\cos^2\theta-1)}{4\pi\varepsilon_0 r^3}$

(D) $V = \frac{Qs(3\cos^2\theta-1)}{4\pi\varepsilon_0 r^2}$



3. (5%) There is a sector of a spherical shell with the cross section as shown in the figure (where $0\leq\alpha<2\pi$) What is the resistance between the top and bottom bases of the sector? (Assume that the electrical conductivity of the sector material is σ)



(A) $R = \frac{1}{2\pi\sigma(1-\cos\alpha)}\left[\frac{1}{a}-\frac{1}{b}\right]$

(B) $R = \frac{1}{\pi\sigma(1-\sin\alpha)}\left[\frac{1}{a}-\frac{1}{b}\right]$

(C) $R = \frac{1}{2\pi\sigma(1+\cos\alpha)}\left[\frac{1}{a}-\frac{1}{b}\right]$

(D) $R = \frac{1}{\pi\sigma(1+\sin\alpha)}\left[\frac{1}{a}-\frac{1}{b}\right]$

4. (5%) A parallel-plate capacitor has plates of area A separated by a distance s. Its dielectric has a conductivity $\sigma=a+bx$, where x is the distance to one plate and a uniform relative permittivity ε_r. With an alternating voltage with the angular frequency ω across the electrodes, there is a current I flowing through the dielectric. What is the electric field in the capacitor?

(A) $\vec{E} = \frac{\vec{I}}{A((a+bx)j\omega\varepsilon_r\varepsilon_0)}$

(B) $\vec{E} = \frac{\vec{I}}{A((a+bx)/j\omega\varepsilon_r\varepsilon_0)}$

(C) $\vec{E} = \frac{\vec{I}}{A(a+bx+j\omega\varepsilon_r\varepsilon_0)}$

(D) $\vec{E} = \frac{\vec{I}}{A(a+bx-j\frac{1}{\omega\varepsilon_r\varepsilon_0})}$

5. (5%) The plane boundary defined by z=0 separates air ($z\geq0$) from a block of iron ($z\leq0$), of which $\mu=5000\mu_o$ If $\vec{B}_1=\hat{x}4-\hat{y}6+\hat{z}12$ is the magnetic field in air, what is the magnetic field $\vec{B}_2$ in iron:

(A) $\vec{B}_2 = \hat{x}0.0008 - \hat{y}0.0012 + \hat{z}12$

(B) $\vec{B}_2 = \hat{x}4 - \hat{y}6 + \hat{z}60000$

(C) $\vec{B}_2 = \hat{x}4 - \hat{y}6 + \hat{z}0.0024$

(D) $\vec{B}_2 = \hat{x}20000 - \hat{y}30000 + \hat{z}12$

注意:背面有試題

6. (5%) Which material type in the following has negative magnetic susceptibility, thus the direction of the induced magnetic dipole moment is opposite to the corresponding applied magnetic field:
(A) Paramagnetic material
(B) Diamagnetic material
(C) Ferromagnetic material
(D) None of the above material have negative magnetic diploe moments

7. (5%) Which following equation is not one of the Maxwell's equations:

(A) $\nabla \times \vec{H} = \vec{J} + \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$

(B) $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

(C) $\nabla \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$

(D) $\nabla \cdot \vec{B} = 0$

8. (5%) The plates of a parallel-plate capacitor has areas of 10 cm^2 each and are separated by 1 cm. The capacitor is filled with a dielectric material with $\varepsilon = 4\varepsilon_o$, where $\varepsilon_o = 8.85 \times 10^{-12}\, F/m$, and the voltage across it is given by $V(t) = 30\cos(2\pi \times 10^6 t)$ (V). What is the displacement current?
(A) $I_d = 2.4\pi\varepsilon_o \times 10^7 sin(2\pi \times 10^7 t)$ (A)
(B) $I_d = 2.4\pi\varepsilon_o \times 10^9 cos(2\pi \times 10^7 t)$ (A)
(C) $I_d = 2.4\pi\varepsilon_o \times 10^9 sin(2\pi \times 10^7 t)$ (A)
(D) None of the above.

9. (5%) Considering a plane electromagnetic wave traveling in a material with a permittivity ε and a permeability μ, what is the phase velocity of the wave?

(A) $\frac{1}{\mu\varepsilon}$

(B) $\frac{1}{\sqrt{\mu\varepsilon}}$

(C) $\mu\varepsilon$

(D) none of the above.

注意:背面有試題

10. (5%) The instantaneous expression of the electric field of a plane wave in vacuum is given by $\vec{E}(z,t) = \hat{a}_x E_0 \cos(\omega t - \beta z)$. The intrinsic impedance (also called the wave impedance) is η_0. What is the instantaneous expression of the Poynting vector?

(A) $\hat{a}_z \frac{E_0^2}{\eta_0}\cos^2(\omega t - \beta z)$

(B) $\hat{a}_z \frac{E_0^2}{2\eta_0}$

(C) $\hat{a}_x \frac{E_0^2}{\eta_0} cos(\omega t - \beta z)$

(D) none of the above.

11. (5%) A linearly polarized plane wave $(\vec{E}_i, \vec{H}_i)$ with a frequency of 100 MHz propagates in vacuum in the +z direction. It impinges normally on a perfectly conducting plane at z = 0 and gets reflected. The reflected wave is denoted by $(\vec{E}_r, \vec{H}_r)$. The incident and the reflected waves form a standing wave. Determine the location nearest to the conducting plane where the total magnetic field $\vec{H}_i + \vec{H}_r$ is zero.

(A) z = -3 (m)

(B) z = -1.5 (m)

(C) z = -0.75 (m)

(D) none of the above.

12. (5%) Total internal reflection can occur at the interface between water and air. Assume the refractive index of water is 1.33. Which one of the following is closest to the critical angle at the water-air interface?

(A) 36°

(B) 42°

(C) 45°

(D) 49°.

13. (5%) The following characteristics have been measured on a distortionless lossy transmission line at 100 MHz:

Characteristic impedance: $Z_0 = 50\ \Omega$

attenuation constant: $\alpha = 0.0869$(dB/m)

phase constant: $\beta = 0.8\pi$ (rad/m)

please evaluate the value of the R in the RLGC model for this distortionless lossy transmission line.

(A) 0.1 Ω/m

(B) 0.5 Ω/m

(C) 4.345 Ω/m

(D) none of the above

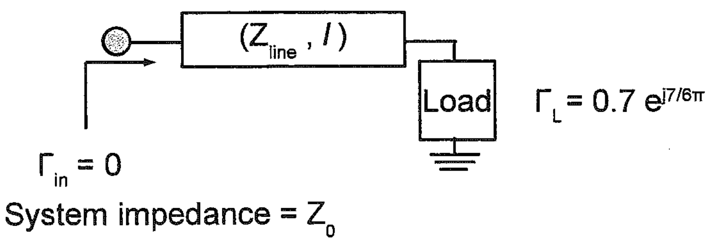
14. (5%) Given a load with a reflection coefficient $\Gamma_L = 0.7\, e^{j7/6\pi}$ under the characteristic impedance (Z_0), as the figure shown below. Now, we use a transmission line with characteristic impedance of Γ_{line} and length of l to match this load to the characteristic impedance (Z_0). Which Z_{line} in the selection items have the best matching condition?

(A) $0.33\, Z_0$

(B) $3.06\, Z_0$

(C) $0.72\, Z_0$

(D) Z_0



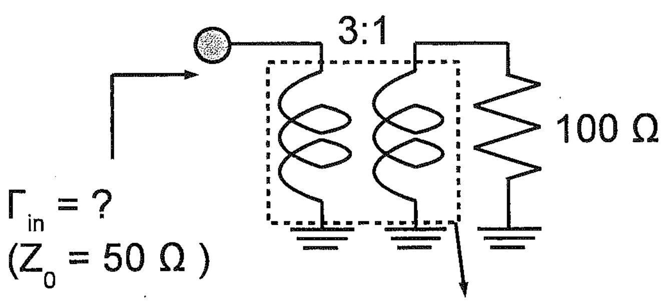
15. (5%) Evaluate the input reflection coefficient (Γ_{in}) of the circuit constructed with an ideal transformer and a resistor as the figure shown below. It is noted that the characteristic impedance for evaluating the reflection coefficient (Z_0) is 50 Ω. Please select the most close value Γ_{in} between the selection items

(A) -0.89

(B) 0.3

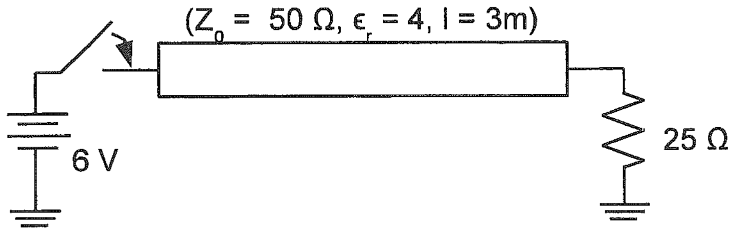
(C) 0.89

(D) -0.3



16. (5%) A d-c voltage (6V) is applied at t=0 directly to the input terminals of an 25-Ω terminated lossless coaxial of 3m length as the figure below. The initial condition of voltage and current of the cable are 0V and 0A. The dielectric constant (ϵ_r) of the insulating material in the cable is 4, and the characteristic impedance of the cable (Z_0) is 50Ω. Determine the voltage value at the midpoint of the line at 60μs.

(A) 6V
(B) 5.3V
(C) 4V
(D) none of the above



17. (5%) A parallel-plate waveguide has the two plates separated by 1 cm and is filled with a lossless dielectric with a dielectric constant of 2.1. What's the total number of waveguide modes that can propagate with the operating wavelength of 3 mm?

(A) 14
(B) 16
(C) 9
(D) none of the above

18. (5%) For the design of symmetric dielectric slab waveguides, given the conditions

(i) smaller refractive index contrast (ii) thicker core layer (iii) higher operation frequency, how many conditions above will let the waveguide more likely to be single-moded?

(A) 1
(B) 2
(C) 3
(D) none of the above

注意:背面有試題

19. (5%) One air-filled rectangular waveguide is connected to the other rectangular waveguide filled with a dielectric characterized by the dielectric constant ε_r. Both waveguides have identical dimensions with a=2b. What's the exact expression for the frequency range over which single-mode opearation will occur in both waveguides?

(A) $\frac{c}{2a\sqrt{\varepsilon_r}} < f < \frac{c}{2a}$

(B) $\frac{c}{2a} < f < \frac{c}{a\sqrt{\varepsilon_r}}$

(C) $\frac{c}{2a\sqrt{\varepsilon_r}} < f < \frac{c}{a}$

(D) none of the above

20. (5%) For an air-filled parallel plate waveguide, if the zigzag angle φ defined below is 36.87° for the TE_2 mode, what would it be for the TE_1 mode at the same frequency?

(A) 72.54°

(B) 25.84°

(C) 17.45°

(D) none of the above