# 電磁學二第一次段考

註：考試時間 10:10 – 12:40 共 120 分鐘。第六到第八題中只需選擇兩題作答，若三題全答，以其中得分較高之兩題列入總分計算。

1) (10%) A filamentary wire carrying current $I$ is closely wound around a toroidal magnetic core of rectangular cross section, as shown in Fig.1. The mean radius of the toroidal core is $a$ and the number of turns per unit length along the mean circumference of the toroidal is $N$. Find (a) the magnetic field intensity in the core and (b) the inductance of the toroid. Assume that $b \ll a$.

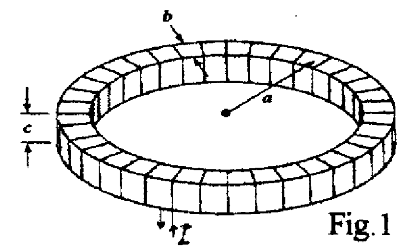


Fig.1

2) (10%) Consider a wire of radius $a=0.5mm$ in a height $d=5mm$ over a ground plane in the air as shown in Fig.2. Find the per-unit-length capacitance, inductance, and the characteristic impedance of the wire. Note that the per-unit-length capacitance between two parallel cylindrical wires of radius $a$ and center-to-center separation $2d$ can be given by $C = \pi\varepsilon_0 / \cosh^{-1}(d/a)$ where $\cosh^{-1} x = \ln(x+\sqrt{x^2-1})$

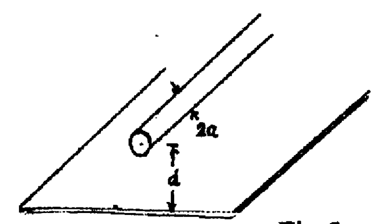


Fig.2

3) (15%) In a system shown in Fig.3(a), the network N consists of a single circuit element (R, L, or C). The system is initially uncharged. The switch S is closed at $t=0$, and the line voltage at $z=0$ is observed to be as shown in Fig.3(b).

(a) Determine whether the circuit element is R, L, or C.

(b) Find the value of $Z_{02}/Z_{01}$.

(c) Find an expression for the value of the circuit element in terms of the area of the shaded region shown in the figure, $Z_{01}$, the reflection coefficient, and $V_0$.

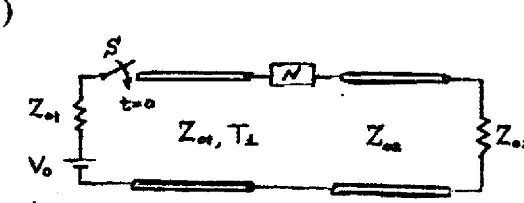


Fig.3(a)

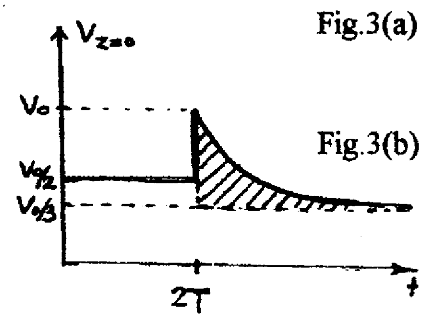


Fig.3(b)

4) (15%) In Fig.4, a (+) wave carrying power P is incident on the junction a-a' from line 1. Find (a) the power reflected into line 1; (b) the power transmitted into line 2; and (c) the power transmitted into line 3.

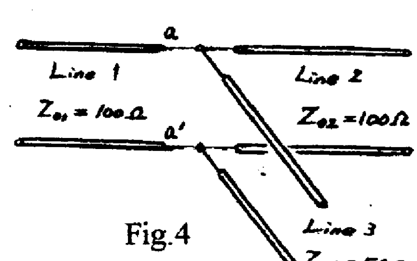


Fig.4

5) (20%) In the system shown in Fig.5, the switch is closed at $t=0$. Assume $V_g(t)$ to be a direct voltage of 100V.

(a) Draw the voltage bounce diagram.

(b) Sketch the line voltage versus $t$ (up to $t=5\mu s$) at $z=\ell/2$

(c) What is the line voltage at $z=\ell/2$ as $t$ tends to infinity.

(d) Sketch the line voltage versus $z$ at $t=1.5\mu s$.

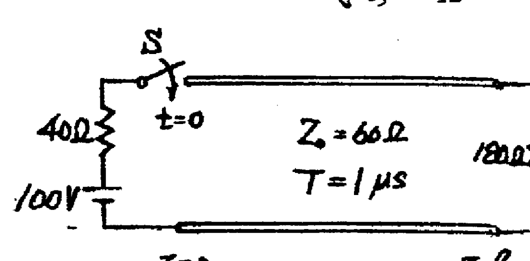


Fig.5

6) (15%) Consider a typical CMOS buffer driver circuit to a 50Ω transmission line. A simplified equivalent circuit for a high-to-low transition can be represented by Fig.6(a) where R=0Ω.

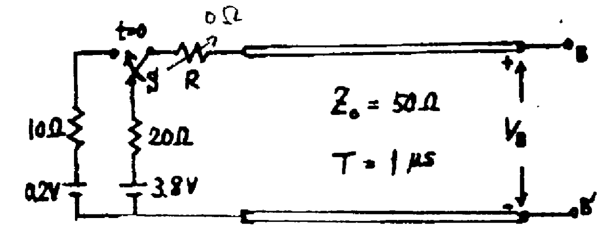


Fig.6(a)

(a) Plot the output voltage waveform $V_B(t)$ versus time (up to $t$=6μs). Note that the transmission line is originally charged up to V=3.8V for $t<0$.

(b) Consider a voltage clamper D as shown in Fig.6(b) is connected to the output port. The diode D is clamped to −0.2V and having the V-I characteristics shown in Fig.6(c). Repeat (a) and compare the results with those obtained in (a). Discuss how the diode can improve the transition characteristics.

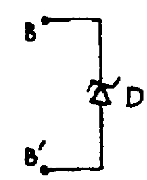


Fig.6(b)

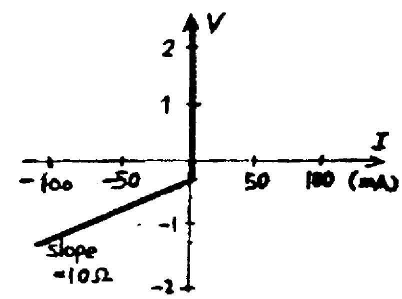


Fig.6(c)

(c) Another way is to add a series resistor at the source end, say R=40Ω in Fig.6(a). Repeat (a) and compare the results with those obtained in (a). Discuss how the series resistance can improve the transition characteristics.

7) (15%) Consider coupled transmission lines of length $\ell$=40cm as shown in Fig.7, for which the mutual capacitance $C_m=0.1C$ and mutual inductance $L_m=0.15L$ where $C$ and $L$ are self capacitance and self inductance, respectively, of the two isolated transmission lines. Let $C$ and $L$ be such that the two transmission lines have characteristic impedance $Z_0=50\Omega$ and propagation speed $v_p=20$ cm/nsec. The line 1 is excited by a source voltage which is a ramped pulse of 2V and with rise time $t_r=1$ nsec, *i.e.*, $V_g(t)=2\ t/t_r$ for $t<t_r$ and $V_g(t)=2$ for $t>t_r$. Find and sketch (a) $V_2(z=0,\ t)$ and (b) $V_2(z=\ell, t)$ when the length of lines is $\ell$=40cm. (c) Also discuss how the pulse width and pulse height will change if the transmission lines are short lines, say $\ell$=5cm.

8) (15%) A section of transmission line can serve as a signal generator. Consider the circuit shown in Fig.8. The switch S is closed to the shorted circuit at $t=0$.

(a) Sketch the line voltage versus time at $z=\ell$.

(b) Design the length to give a periodic signal of frequency 1GHz.

(c) Sketch the line voltage along the transmission line at $t=\ell/v_p$.

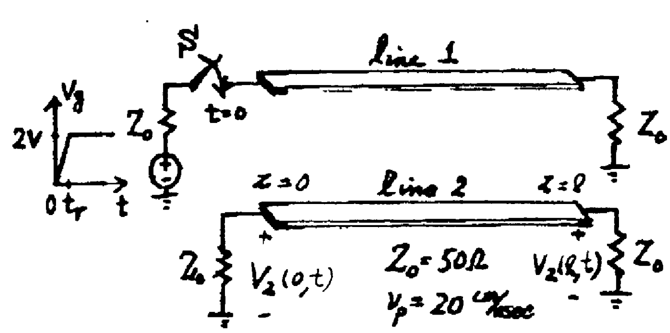


Fig.7

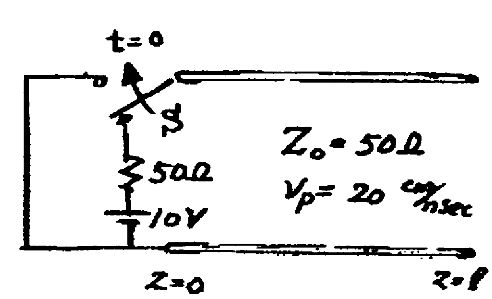


Fig.8