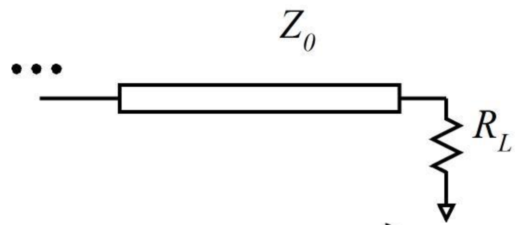
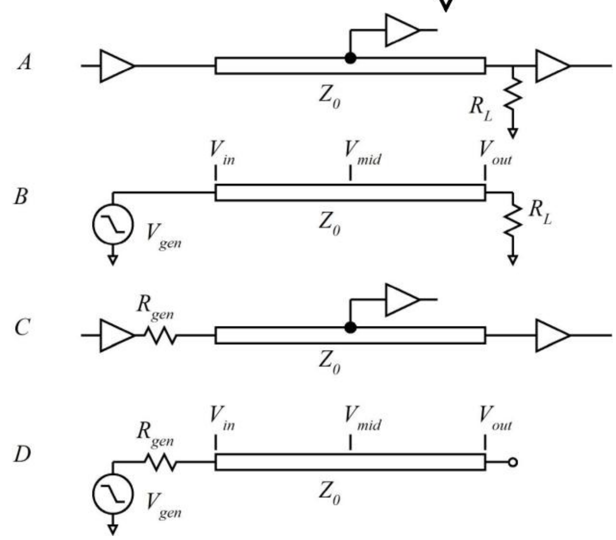
ECE 145a /218A first problem set (basics of transmission lines and lumped elements)

Problem 1: A transmission line has 50 Ohms characteristic impedance and a load impedance of (a) 25 Ohms (b) 50 Ohms (c) 100 Ohms. Compute in each case the voltage reflection coefficient.



Problem 2: lattice diagrams:
Draw lattice diagrams for the 2 cases: (a/b) and (c/d), and draw clean plots of Vin, Vmid, and Vout.

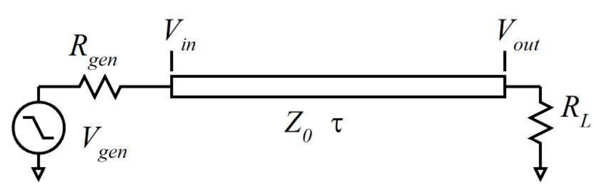


Case (a/b) logic gate with low (zero ohms) output impedance drives a 75 Ohm line of 5 cm length and 10^8 m/s propagation velocity. The equivalent circuit is in (b). The load impedance is 75 Ohms and Vgen is a 500 mV step-function.

Case (c/d) logic gate with 75 ohms output impedance drives the same line The equivalent circuit is in (d). The load impedance is infinity and Vgen is a 500 mV step-function.

Comment of on the relative utility of the 2 schemes for distributing logic signals using a transmission-line bus

Problem 3: lumped-distributed relationships



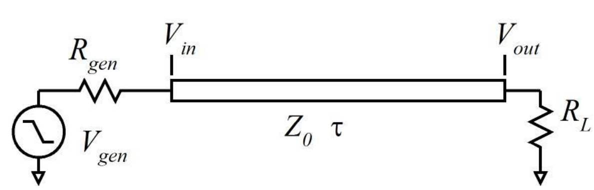
In all cases: Z_o = 100 Ohms, $\tau = l / v =$ 1 ps, and V_{gen} is a 1 V step-function. For cases (a,b,c), Compute and plot $V_{in}(t)$ using lattice diagram methods.

Case a: R_L =1000 Ohms, R_{gen} =1000 Ohms.

Case b: R_L =10 Ohms, R_{gen} =10 Ohms.

Case c: R_L =0 Ohms, R_{gen} =1000 Ohms.

Problem 4: lumped-distributed relationships



In all cases: Z_o = 100 Ohms, $\tau = l / v =$

1 ps, and V_{gen} is a 1 V step-function.

For cases (a,b,c), replace the transmission-line with a T or Pi equivalent circuit, compute and plot $V_{in}(t)$ using basic circuit analysis.

In (a) and (b) first compute L/R and RC time constants, and ignore either L or C if the associated time constant is more than 10:1 less than the dominant time constant.

Case a: R_L =1000 Ohms, R_{gen} =1000 Ohms.

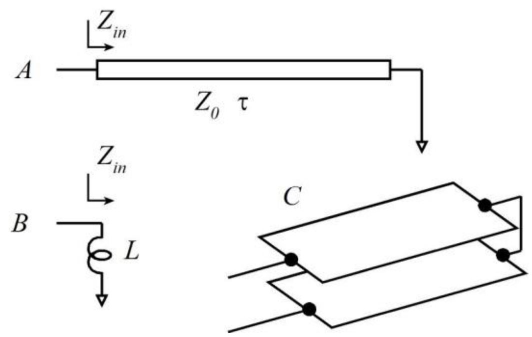
Case b: R_L =10 Ohms, R_{gen} =10 Ohms.

Case c: R_L =0 Ohms, R_{gen} =1000 Ohms.

Problem 5: lumped-distributed relationships

A transmission line (image C) has length l = 300 microns and propagation velocity equal to the speed of light in vacuum. Z_o = 100 Ohms. The plate vertical separation is 1 mm. Using approximate microstrip-line formulas, compute the *width* of the conductors.

This leads to the equivalent circuit (a) . From this, compute the line inductance and use this value in (b).

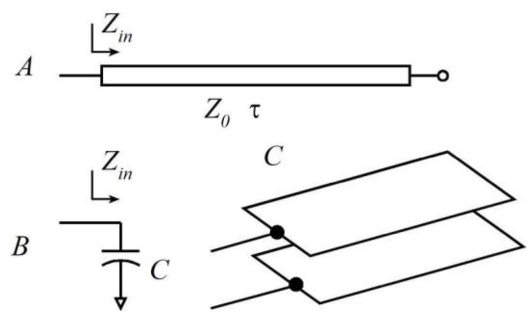


Using the Smith chart, make a quantitative graph comparing Z_{in} of cases (a) and (b) over a frequency range extending from DC to $f = 1/\tau = v/l$

Problem 6: lumped-distributed relationships

A transmission line (image C) has length l = 300 microns and propagation velocity equal to the speed of light in vacuum. Z_o = 100 Ohms.

This leads to the equivalent circuit (a) . From this, compute the line capacitance and use this value in (b).



Using the Smith chart, make a quantitative graph comparing Z_{in} of cases (a) and (b) over a frequency range extending from DC to $f = 1/\tau = v/l$