1. Design a microstrip stepped impedance LPF as the example 8.6 in p.424~426 by using the ladder circuit given in Fig. 8.25(b) instead of that in Fig. 8.25(a).
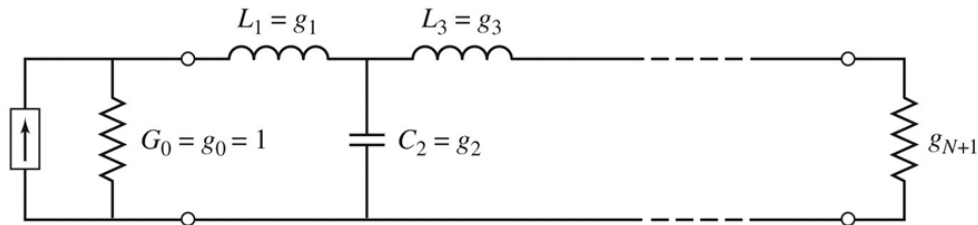

Fig. 8.25(b)

(1) Give Fig. <u>8.26</u> to give the number of elements N= <u>6</u> for $\dfrac{\omega}{\omega_c} - 1 = \underline{0.6}$.

(2) Give the low-pass prototype values $g_1 = \underline{0.517}$, $g_2 = \underline{1.414}$, $g_3 = \underline{1.932}$, $g_4 = \underline{1.932}$, $g_5 = \underline{1.414}$, $g_6 = \underline{0.517}$.

(3) Give the low-pass prototype elements with unit $L_1 = \underline{0.517\text{H}}$, $C_2 = \underline{1.414\text{F}}$, $L_3 = \underline{1.932\text{H}}$, $C_4 = \underline{1.932\text{F}}$, $L_5 = \underline{1.414\text{F}}$, $C_6 = \underline{0.517\text{F}}$, and $\omega_c = \underline{1\text{rad/sec}}$.

(4) Give the equations to calculate the impedance and frequency scaling for inductance $L' = \dfrac{R_o L}{\omega_c}$ and capacitance $C' = \dfrac{C}{R_o \omega_c}$, then give the equations of the impedance of high line impedance of L' as $j\omega_c L' = \underline{jZ_h \beta l_h}$ and the impedance of low line impedance of C' as $\dfrac{1}{j\omega_c C'} = \dfrac{Z_l}{j\beta l_l}$.

(5) Give the electrical lengths in terms of high and low line impedances of Z_h and Z_l as $\underline{\beta l_h = \dfrac{\omega_c L'}{Z_h} = \dfrac{\omega_c}{Z_h}\dfrac{R_o L}{\omega_c} = \dfrac{R_o L}{Z_h}}$ and $\underline{\beta l_l = Z_l \omega_c C' = Z_l \omega_c \dfrac{C}{R_o \omega_c} = \dfrac{Z_l C}{R_o}}$, where βl_l and $\beta l_h < \underline{45°}$.

(6) Give the electrical lengths of low-pass filter elements as $\beta l_{h,1} = \underline{\dfrac{50 \times 0.517}{120} \dfrac{180}{\pi} = 12.3°}$, $\beta l_{l,2} = \underline{\dfrac{20 \times 1.414}{50} \dfrac{180}{\pi} = 32.4°}$, $\beta l_{h,3} = \underline{\dfrac{50 \times 1.932}{120} \dfrac{180}{\pi} = 46.1°}$, $\beta l_{l,4} = \underline{\dfrac{20 \times 1.932}{50} \dfrac{180}{\pi} = 44.3°}$, $\beta l_{h,5} = \underline{\dfrac{50 \times 1.414}{120} \dfrac{180}{\pi} = 33.8°}$, $\beta l_{l,6} = \underline{\dfrac{20 \times 0.517}{50} \dfrac{180}{\pi} = 11.8°}$.

(7) The results of lumped LPF, step-impedance LPF given in Fig. 8.25 (a) and Fig. 8.25 (b) are <u>Y</u>.

Simulation Results: The ports of LPF in this ADS simulation are given as the following table.

ports 1 and 2	lumped LPF in Ex. 8.6
ports 3 and 4	step-impedance LPF in Ex. 8.6
ports 5 and 6	lumped LPF in this examination
ports 7 and 8	step-impedance LPF in this examination

S-PARAMETERS

S_Param
SP1
Start= 1 Hz
Step= (1*fc) Hz

Term1
Num=1
Z=Z0 Ohm

C
C1
C=(0.517/(2*pi*fc*Z0)) F

L
L1
L=(Z0*1.414/(2*pi*fc)) H
R=0

C
C2
C=(1.932/(2*pi*fc*Z0)) F

L
L2
L=(Z0*1.932/(2*pi*fc)) H
R=0

C
C3
C=(1.414/(2*pi*fc*Z0)) F

L
L3
L=(Z0*0.517/(2*pi*fc)) H
R=0

Term2
Num=2
Z=Z0 Ohm

Term3
Num=3
Z=Z0 Ohm

TLIN
TL7
Z=Z0 Ohm
E=11.8
F=fc Hz

TLIN
TL8
Z=120 Ohm
E=33.8
F=fc Hz

TLIN
TL9
Z=Z0 Ohm
E=14.3
F=fc Hz

TLIN
TL10
Z=120 Ohm
E=46.1
F=fc Hz

TLIN
TL11
Z=Z0 Ohm
E=32.4
F=fc Hz

TLIN
TL12
Z=120 Ohm
E=12.3
F=fc Hz

Term4
Num=4
Z=Z0 Ohm

Term5
Num=5
Z=Z0 Ohm

L
L4
L=(Z0*0.517/(2*pi*fc)) H
R=0

C
C4
C=(1.414/(2*pi*fc*Z0)) F

L
L5
L=(Z0*1.932/(2*pi*fc)) H
R=0

C
C5
C=(1.932/(2*pi*fc*Z0)) F

L
L6
L=(Z0*1.414/(2*pi*fc)) H
R=0

C
C6
C=(0.517/(2*pi*fc*Z0)) F

Term6
Num=6
Z=Z0 Ohm

Term7
Num=7
Z=Z0 Ohm

TLIN
TL13
Z=120 Ohm
E=12.3
F=fc Hz

TLIN
TL14
Z=Z0 Ohm
E=32.4
F=fc Hz

TLIN
TL15
Z=120 Ohm
E=46.1
F=fc Hz

TLIN
TL16
Z=Z0 Ohm
E=14.3
F=fc Hz

TLIN
TL17
Z=120 Ohm
E=33.8
F=fc Hz

TLIN
TL18
Z=Z0 Ohm
E=11.8
F=fc Hz

Term8
Num=8
Z=Z0 Ohm

dB(S(7,8)) dB(S(6,5)) dB(S(4,3)) dB(S(2,1))

freq, GHz