CHAPTER 9

Structure for Discrete-Time Systems

Basic Problems

15. (a) Solution:

$$H(z) = \frac{0.2 + 0.1z^{-1} + z^{-2}}{0.9 - 0.2z^{-2}}$$

(b) Solution:
The difference equation is:

$$0.9y[n] = 0.2x[n] + 0.1x[n-1] + x[n-2] + 0.2y[n-2]$$

16. Solution:
The system function of system (a) is

$$H_a(z) = \frac{1 - z^{-1}}{(1 - \frac{1}{2}z^{-1})(1 + \frac{1}{4}z^{-1})}$$

The system function of system (b) is:

$$H_b(z) = \frac{2 - \frac{1}{4}z^{-1}}{(1 - \frac{1}{2}z^{-1})(1 + \frac{1}{4}z^{-1})}$$

17. (a) See graph below.

(b) See graph below.

(c) See graph below.

(d) See graph below.

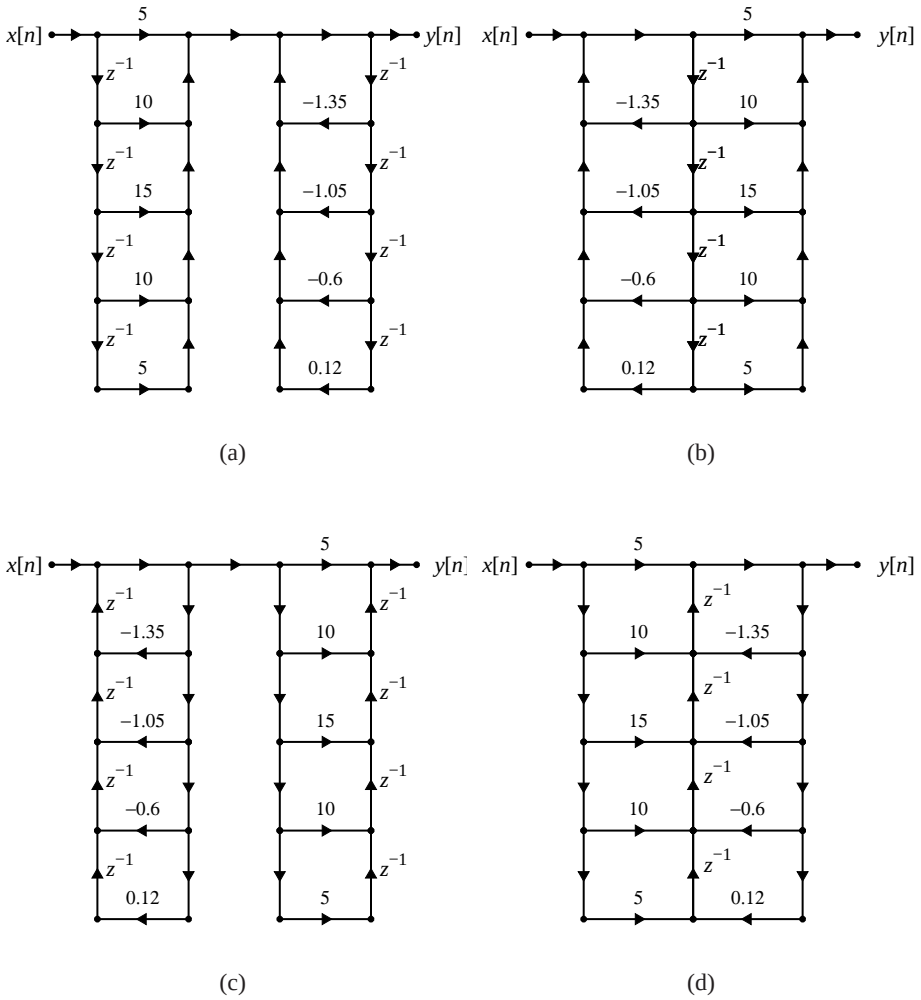


FIGURE 9.1: (a) Normal direct I form. (b) Normal direct II form. (c) Transposed direct I form. (d) Transposed direct II form.

18. (a)

    (b) See plot below.

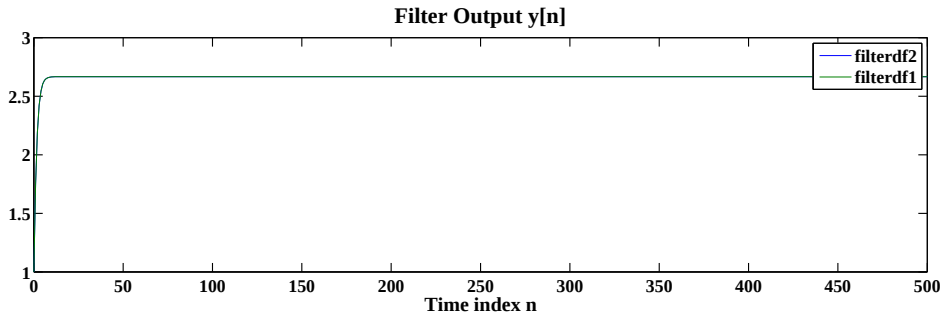


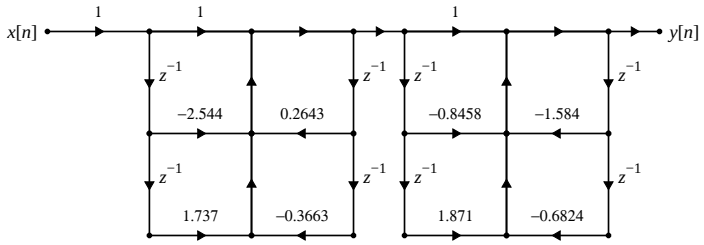
FIGURE 9.2: Numerical filter output $y[n]$ computed by `filterdf2` function compared to the output of `filterdf1` function.

19. (a) See graph below.

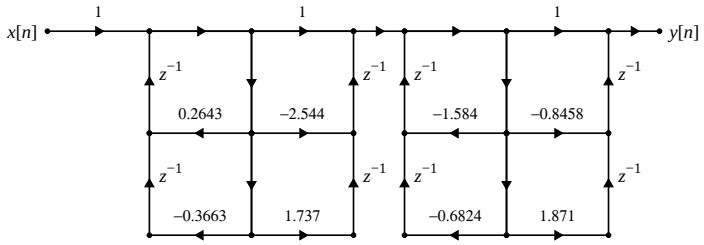
    (b) See graph below.

    (c) See graph below.

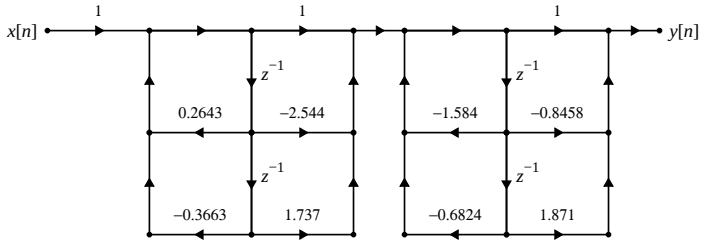
    (d) See graph below.



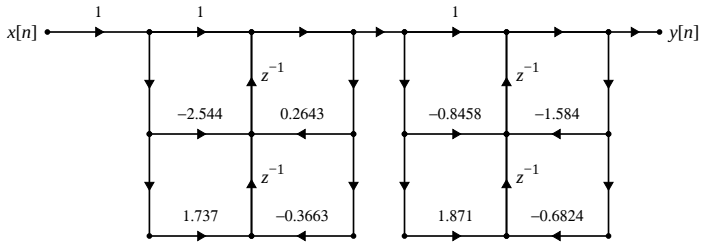
(a)



(b)



(c)



(d)

FIGURE 9.3: (a) Cascade form with second-order sections in normal direct form I. (b) Cascade form with second-order sections in transposed direct form I. (c) Cascade form with second-order sections in normal direct form II. (d) Cascade form with second-order sections in transposed direct form II.

20. (a)

    (b) See plot below.

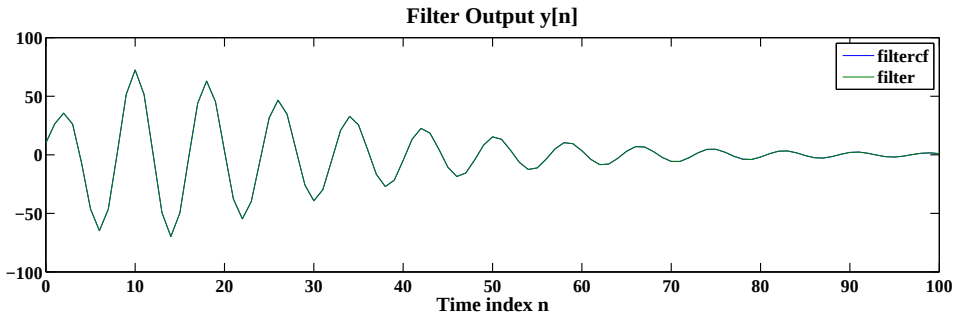


FIGURE 9.4: Numerical filter output $y[n]$ computed by `filtercf` function compared to the output of `filter` function.

21.

22. See plots below.

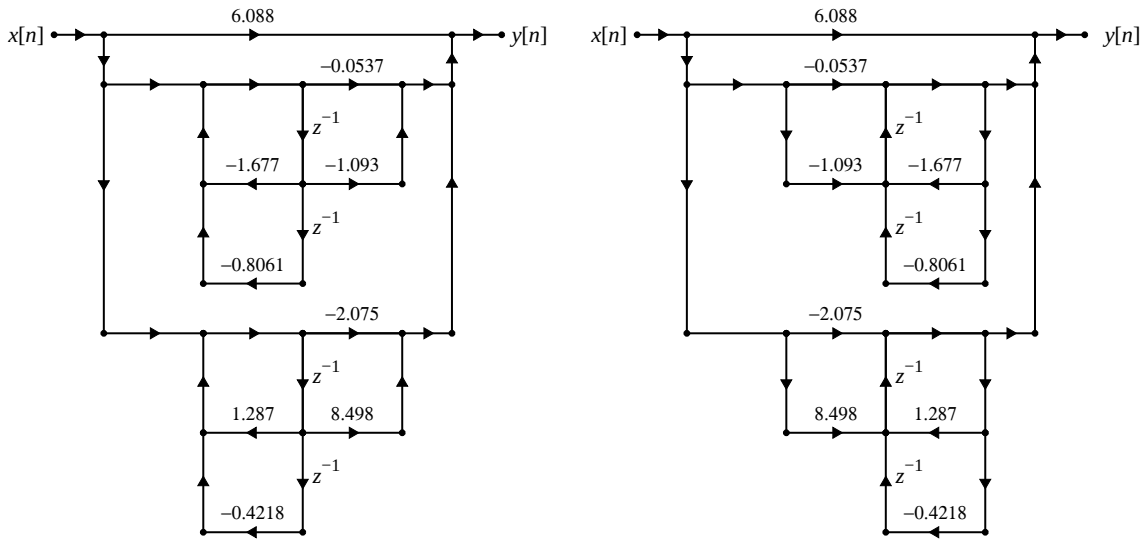


FIGURE 9.5: (a) Parallel form structure with second-order section in direct form II normal. (b) Parallel form structure with second-order section in direct form II transposed.

23. (a) See graph below.
    (b) See graph below.
    (c) See graph below.

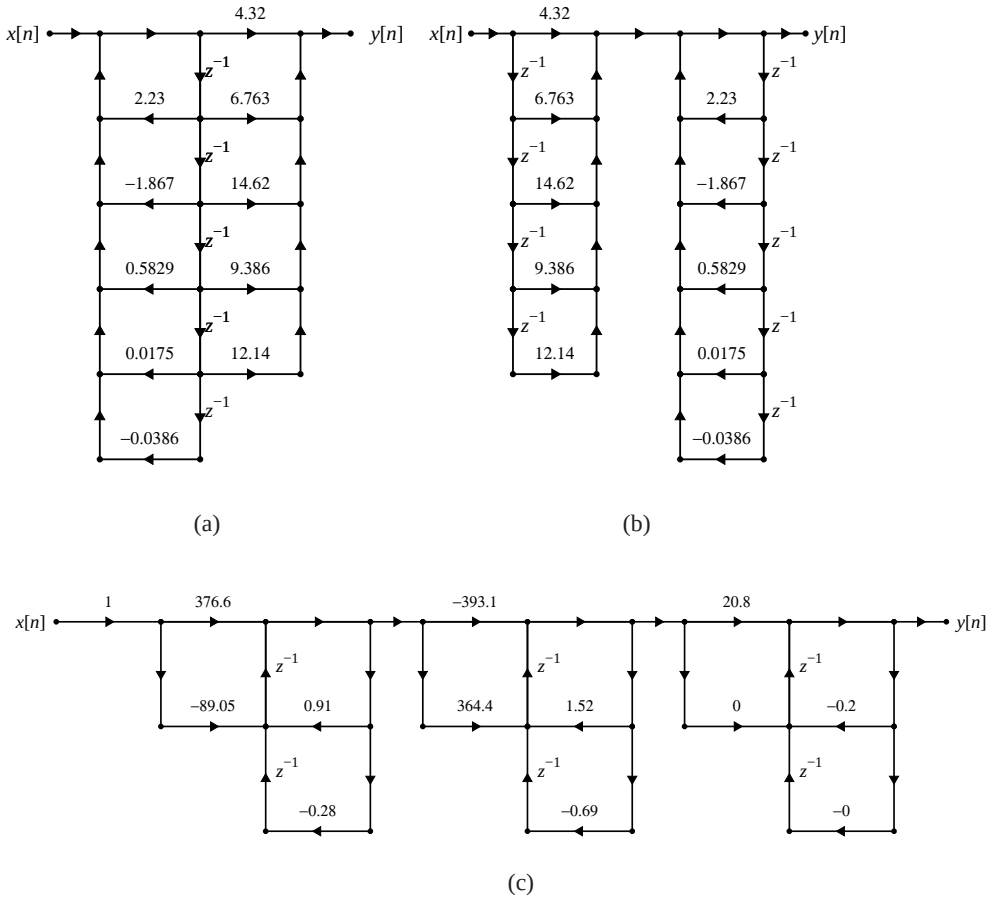


FIGURE 9.6: (a)Direct form II (normal). (b) Direct form I (normal). (c) Cascade form with transposed second-order sections.

24. (a) See graph below.
    (b) See graph below.
    (c) See graph below.

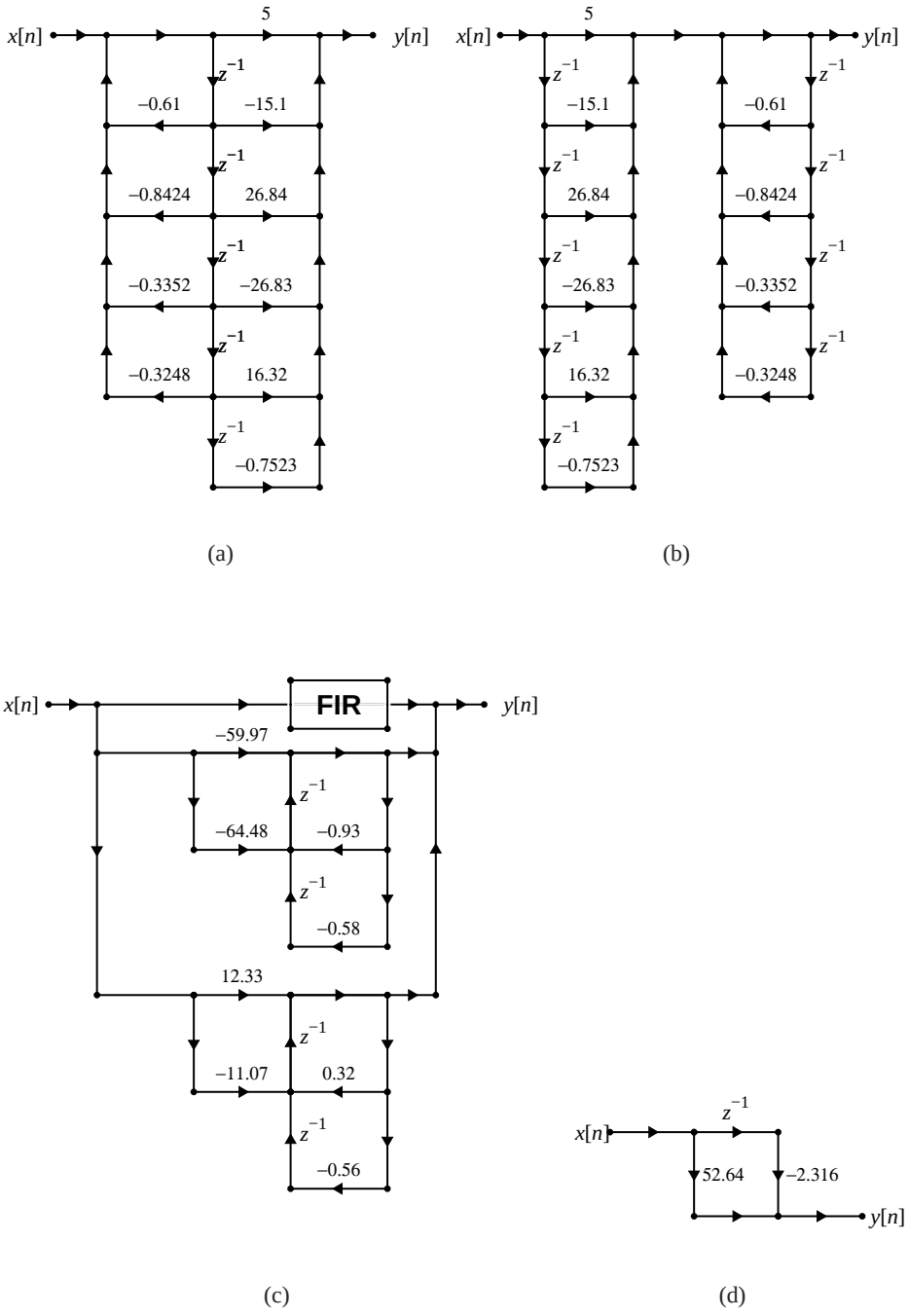


FIGURE 9.7: (a) Direct form II (normal). (b) Direct form I (normal). (c) Parallel form with transposed second-order sections. (d) FIR implementation in part (c).

25. (a)

    (b) See plot below.

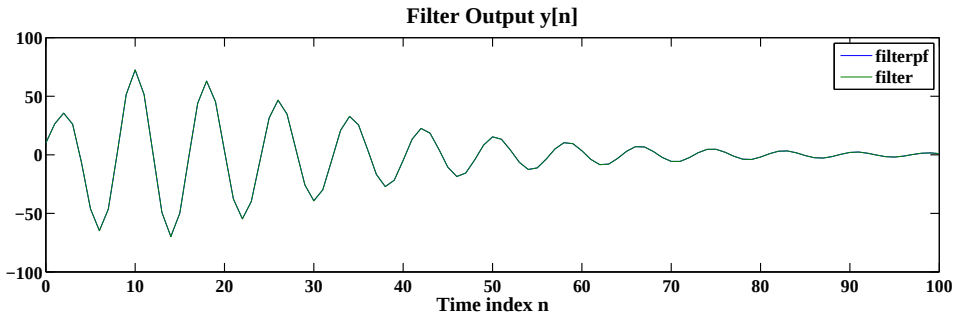


FIGURE 9.8: Numerical filter output $y[n]$ computed by `filterpf` function compared to the output of `filter` function.

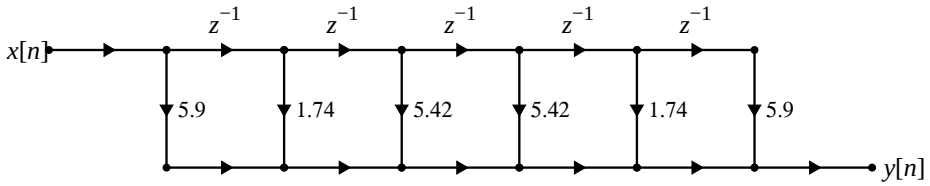
26. (a) See graph below.

    (b) See graph below.

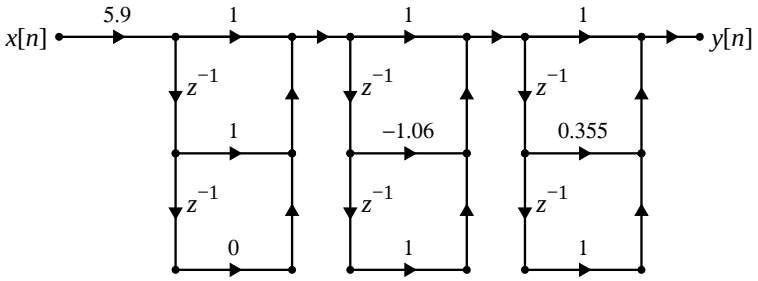
    (c) See graph below.

    (d) See graph below.

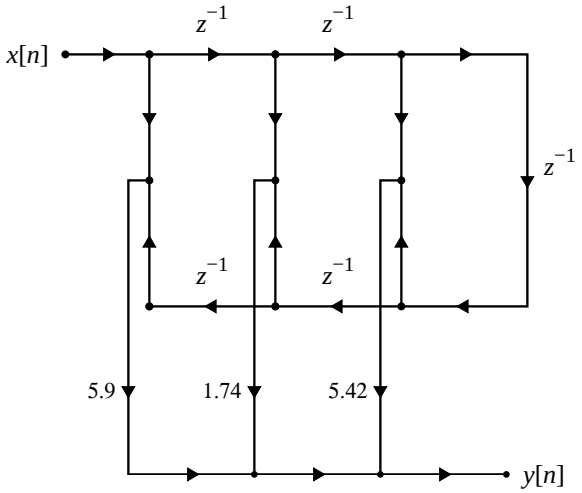
    (e) tba



(a)

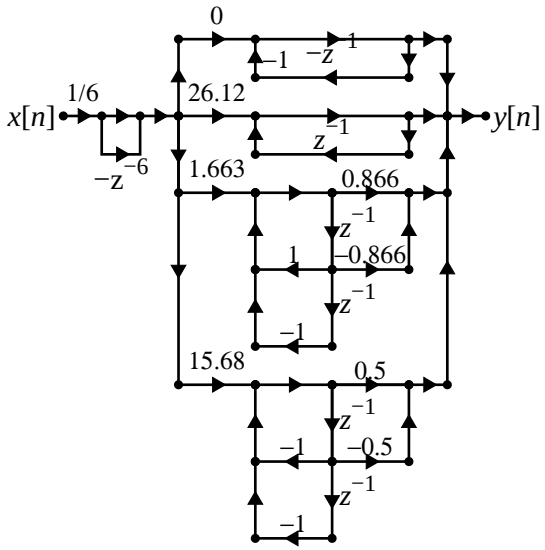


(b)



(c)

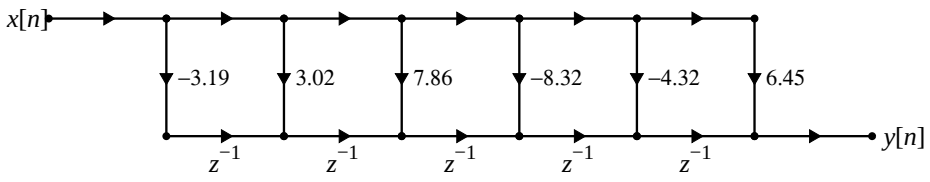
FIGURE 9.9: (a) Direct form (normal). (b) Cascade form. (c) Linear-phase form.



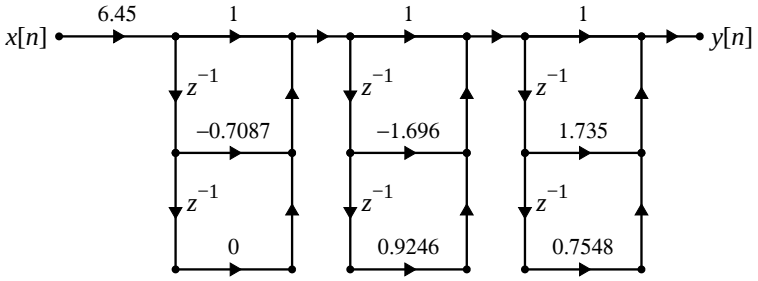
(a)

FIGURE 9.10: (a) Frequency-sampling form.

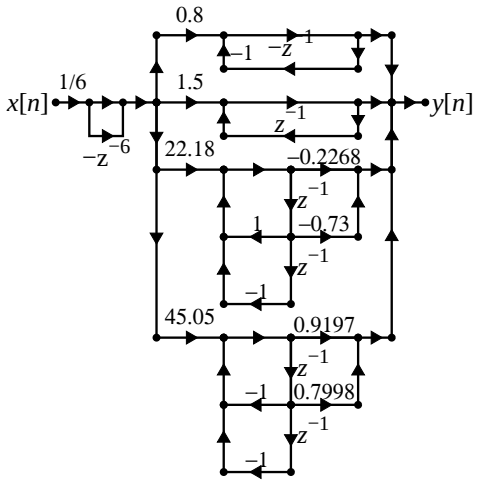
27. (a) See graph below.
    (b) See graph below.
    (c) See graph below.
    (d) tba



(a)



(b)



(c)

FIGURE 9.11: (a) Direct form (normal). (b) Cascade form. (c) Frequency-sampling form.