7 DIGITAL FILTER REALIZATION

Example 1 Elliptic pass-band filter design

$\omega_{P1} = 0.2\pi$, $\omega_{P2} = 0.25\pi$, $\omega_{S1} = 0.1\pi$, $\omega_{S2} = 0.3\pi$, pass-band ripple $\Delta p = 0.1$, stop-band ripple $\Delta s = 0.001$

Solution[1]

```
[b,a,v,u,C]=iirdes('ell','p',[0.1 0.2 0.25 0.3]*pi,0.1,0.001);
freqz(b,a,1000)                 % display filter characteristics
```

Example 2 Compute filter output for direct realizations

Solution

```
x=rand(1,1000);                 % generate random input signal
y=filter(b,a,x);                % reference computation by filter function
y1=direct(1,b,a,x)              % direct form computation (slower than filter)
y2=direct(2,b,a,x)              % transposed form computation (slower than filter)
subplot(3,1,1), plot(y)         % compare results
subplot(3,1,2), plot(y-y1)
subplot(3,1,3), plot(y-y2)
```

Example 3 Compute filter output for parallel realizations

Solution

```
[c,nsec,dsec]=tf2rpf(b,a);      % note that c is different than C in the Example 1
y=filter(b,a,x);                % reference computation by filter function
yp=parallel(c,nsec,dsec,x)      % parallel form computation (slower than filter)
subplot(2,1,1), plot(y)         % compare results
subplot(2,1,2), plot(y-yp)
```

Example 4 Compute filter output for cascade realizations

Solution

```
[nsec,dsec]=pairpz(v,u);        % note that u,v are from the Example 1
y=filter(b,a,x);                % reference computation by filter function
yc=cascade(C,nsec,dsec,x)       % cascade form computation (slower than filter)
subplot(2,1,1), plot(y)         % compare results
subplot(2,1,2), plot(y-yc)
```

Example 5 Draw block diagram (including actual coefficient values and their signs!) of each realization

Example 6 Design cascade, parallel and direct realizations of digital filter in your final project

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[1] Note that normalized frequencies are from $\left(0,\pi\right\rangle$ interval