HW1  All solutions prepared by HPH

**Prob 1a  code**
(the codes for the other problems are not provided as they can be easily modified from this one)

```
clear
dx = 0.05; dt = 0.01; C = 1; A1 = 1-C*dt/dx; A2 = C*dt/dx;
x = [0:dx:20];
N = length(x);
for k = 2:N
    if (x(k) >= 4) && (x(k) <= 6)
        u(k)  = cos(0.5*pi*(x(k)-5));
    else
        u(k) = 0;
    end
end
u(1) = u(N);
for k = 1:N
    uplot(1,k) = u(k);
end
for iout = 1:5
for n = 1:400
    for k = 2:N
        u1(k)  = A1*u(k)+A2*u(k-1);
    end
    u1(1) = u1(N);
    for k = 1:N
        u(k) = u1(k);
    end
end
for k = 1:N
    uplot(iout+1,k) = u(k);
end
end
plot(x,uplot(1,:),'k-',x,uplot(2,:),'r-',x,uplot(3,:),'b-',...
     x,uplot(4,:),'m-',x,uplot(5,:),'g-',x,uplot(6,:),'k--')
axis([0 20 0 1.5])
legend('t = 0','t = 4','t = 8','t = 12','t = 16','t = 20',...
    'Location','NorthEast')
xlabel('x');ylabel('u(x,t)')
```
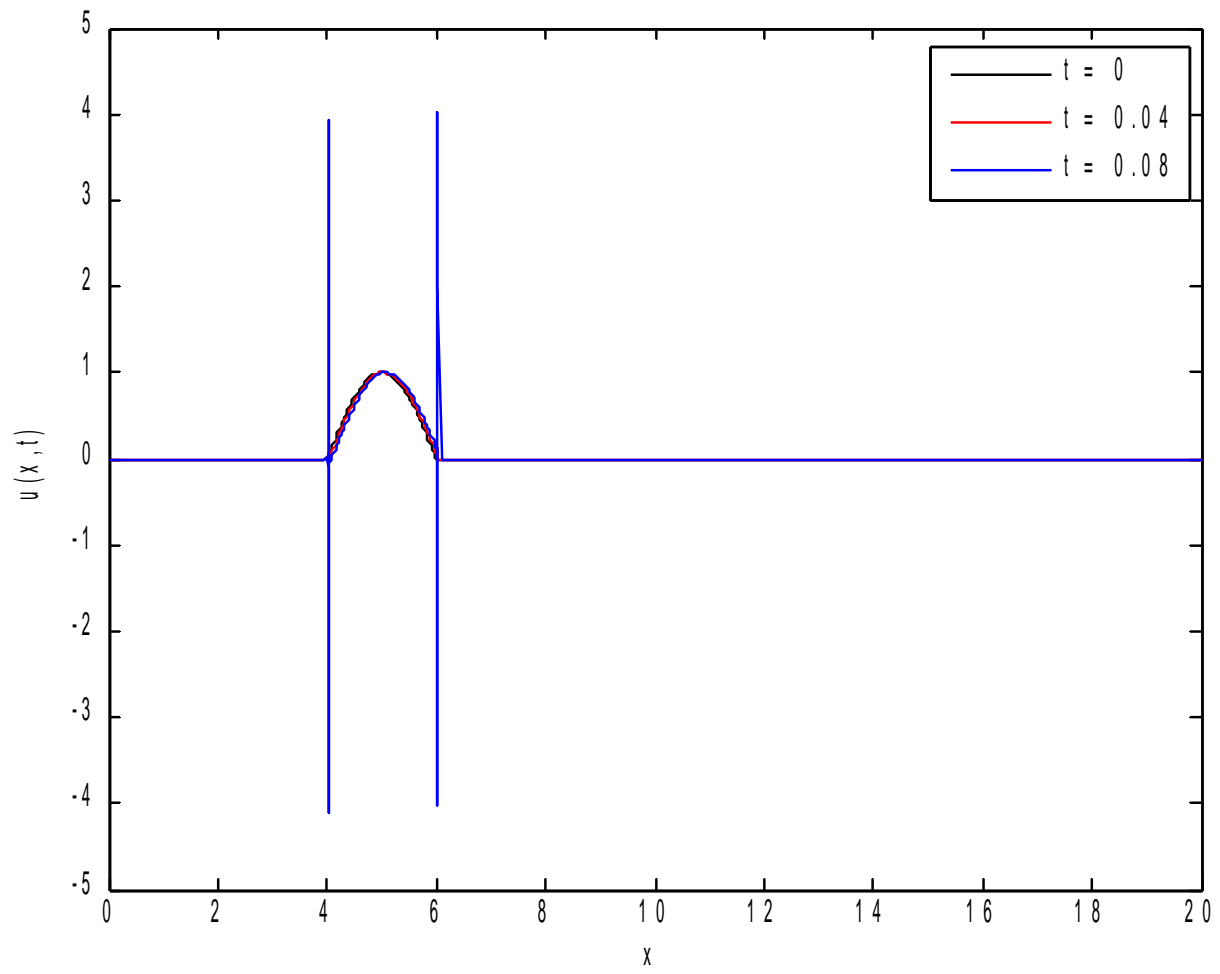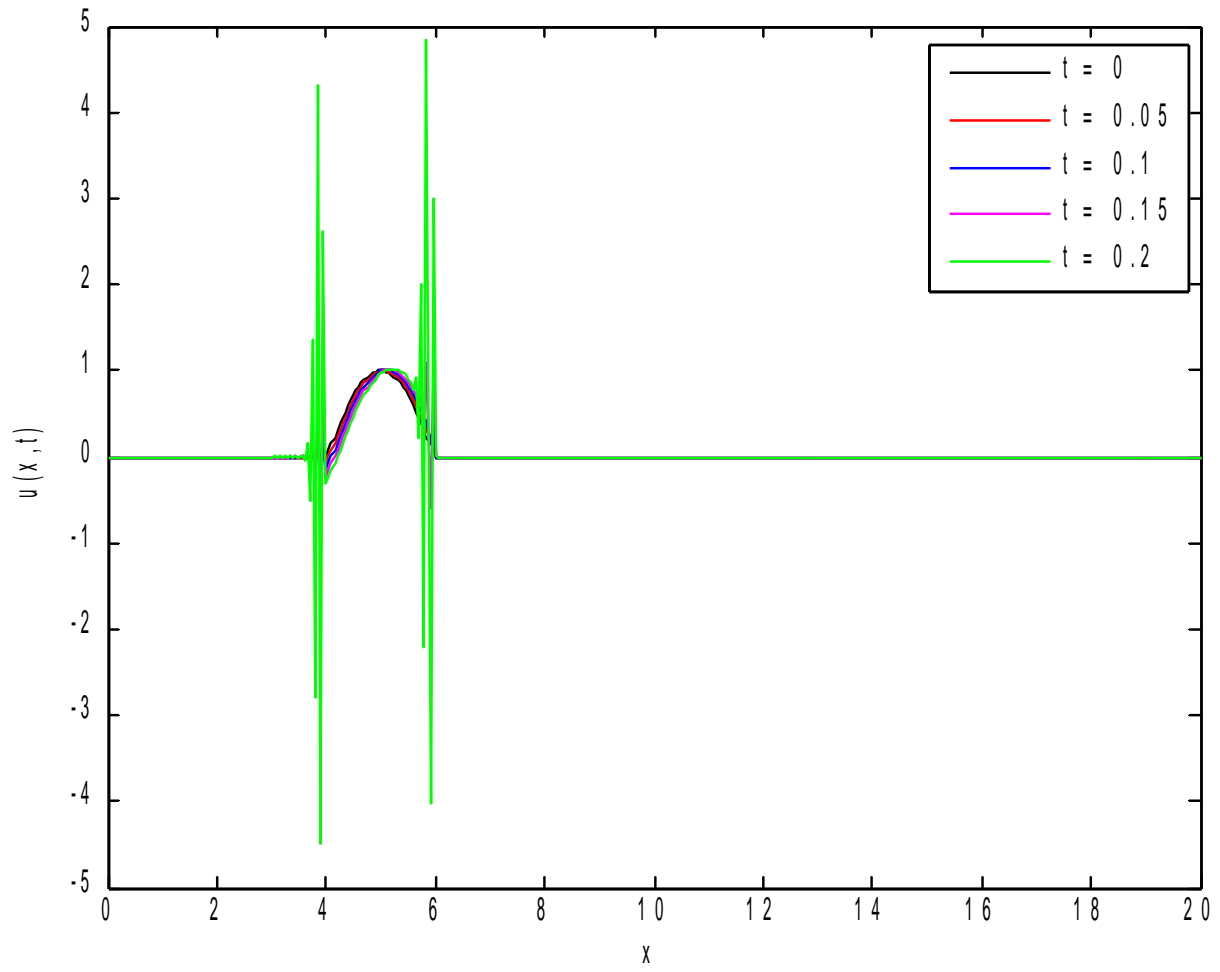
Prob 1a plot
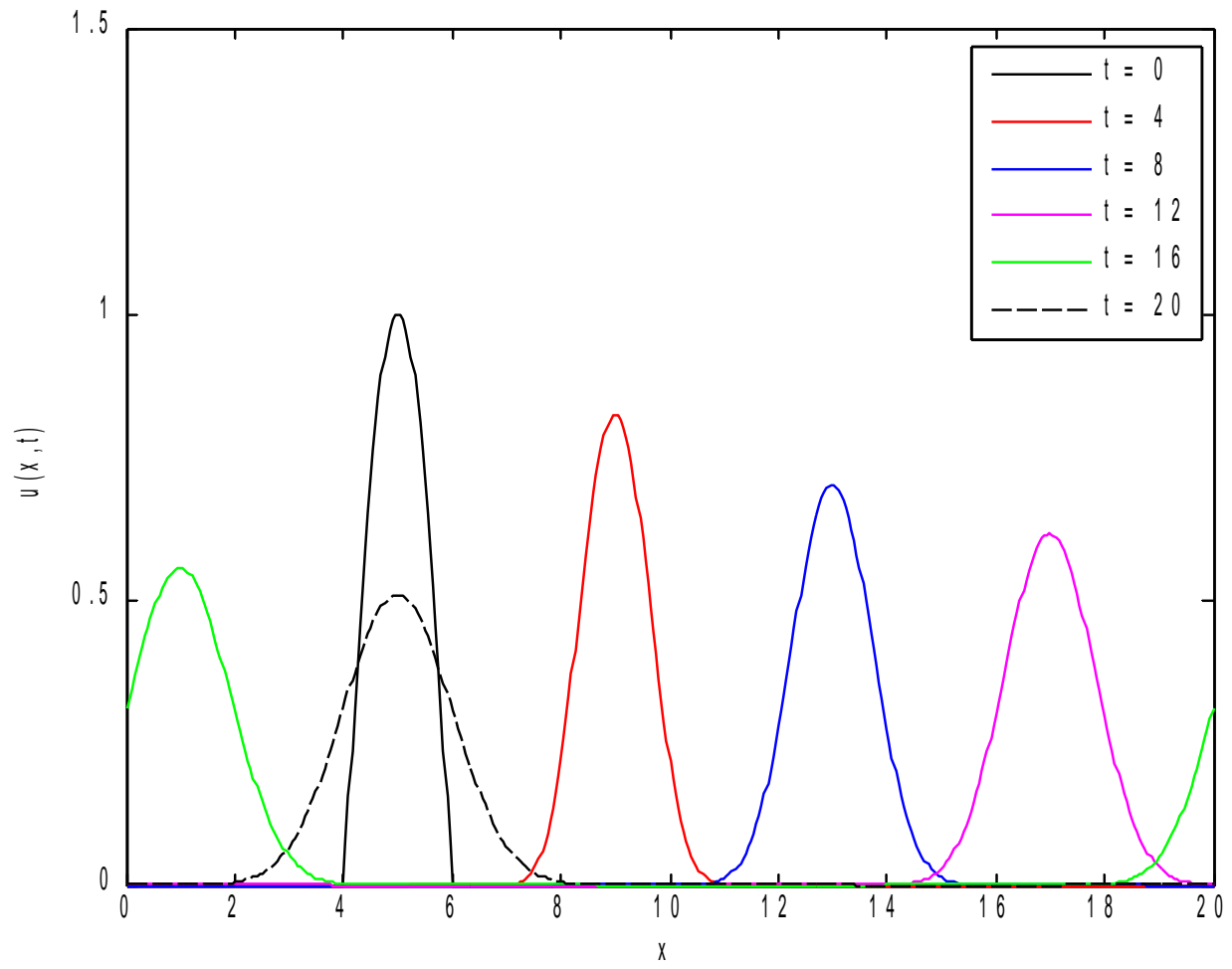
Prob 1b plot
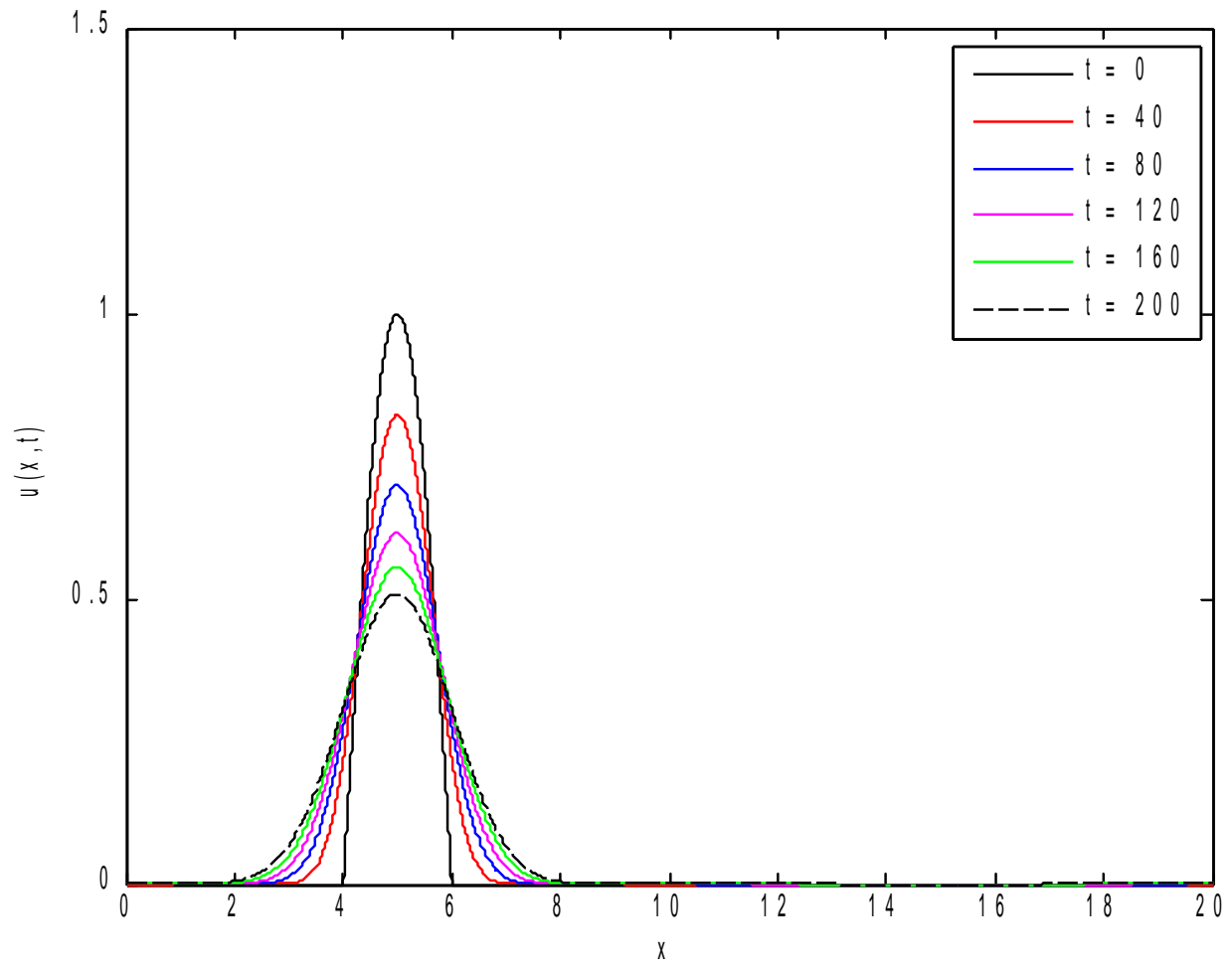
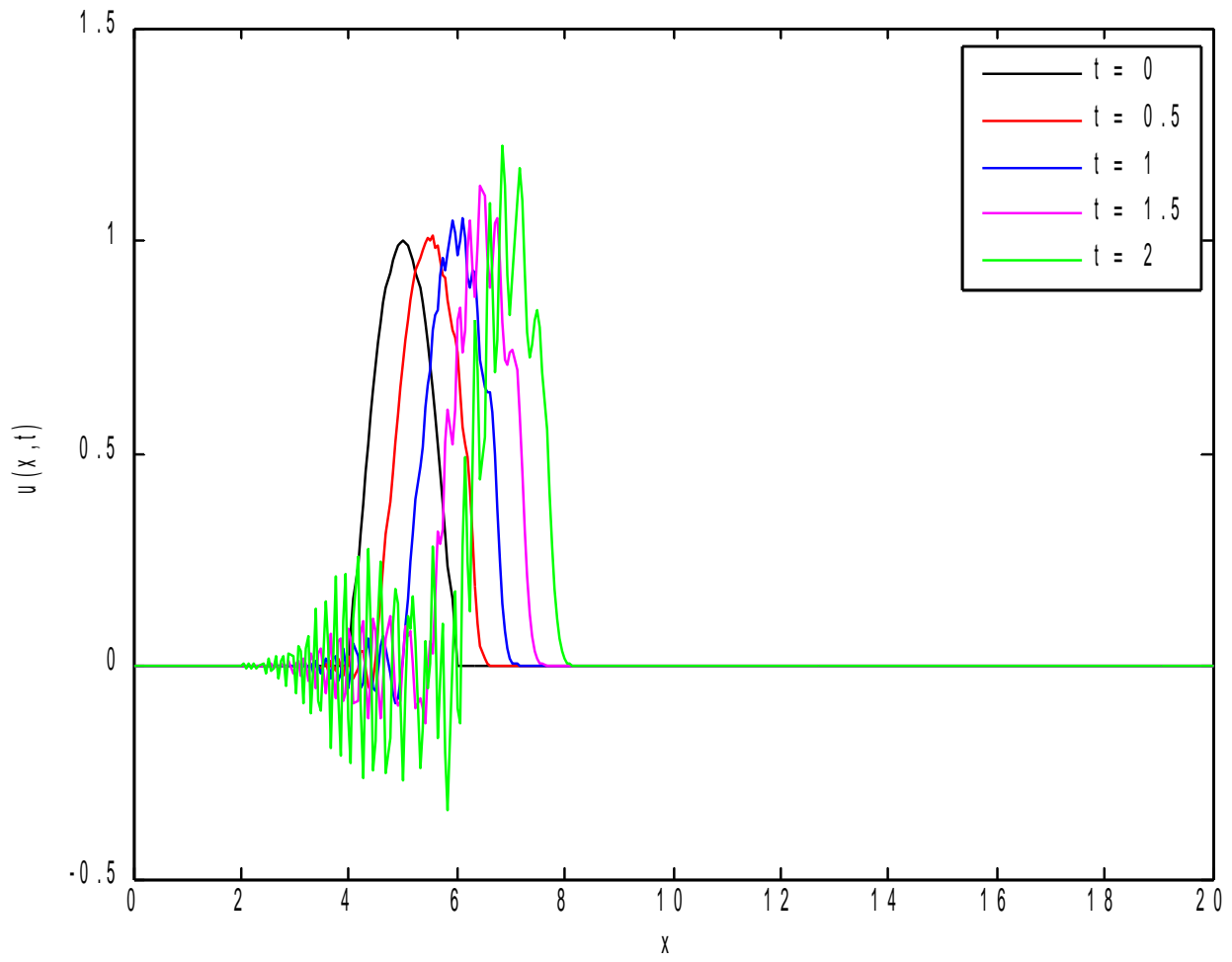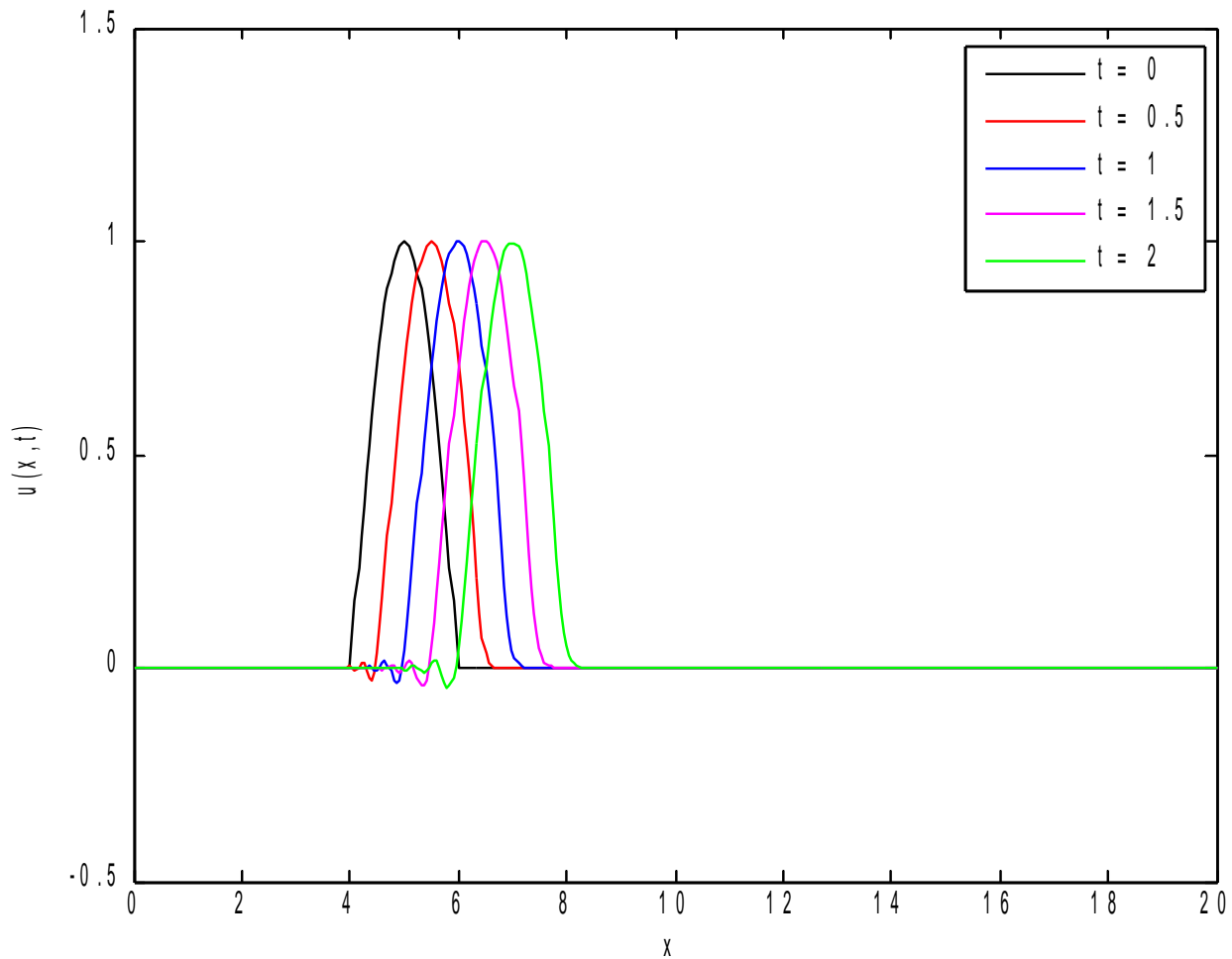Prob 1c plot

Prob 2 plot

Prob 3 plot

Prob 4  plot



Summary:

Prob1:
(a) and (b) The upstream (FTBS) scheme works when the numerical stability criterion is satisfied.
(c) The upstream scheme does not work if the stability criterion is not satisfied.

Prob2:
The downstream (FTFS) scheme never works.

Prob3:
Even though it works for a short time, the FTCS scheme eventually fails because of numerical instability.
(This is revisited in Prob 2 of HW3)

Prob4:
The Lax-Wendroff scheme works when the numerical stability criterion is satisfied.  Except for producing a potentially undesirable "oscillatory tail", it generally outperforms the 1st-order (FTBS) scheme.