MATLAB Program for Exponential Growth: Graph of ODE vs CTMC

```
%ODE Model for Exponential Growth: dx/dt=(b-d)x
%and Markov Chain Model
x0=2; b=2; d=1.25; % Initial value and parameters
x=[0:.1:8];
y=x0*exp((b-d).*x);% Deterministic solution
set(gca,'fontsize',18);
plot(x,y,'k--','Linewidth',2);
hold on
%Five Stochastic Sample Paths for Markov chain
for j=1:5
   clear n t
   t(1,j)=0;
   tt=1;
   n(tt)=x0;
%Continue until hit zero or time steps reach 500
   while n(tt)>0 & tt<500
     u1=rand; u2=rand; %uniform random numbers
     t(tt+1,j)=-log(u1)/(b*n(tt)+d*n(tt))+t(tt,j);
     tt=tt+1;
     if u2<b/(b+d)
        n(tt)=n(tt-1)+1; % Birth
     else
       n(tt)=n(tt-1)-1; % Death
     end
   end
   s=stairs(t(:,j),n,'r-','Linewidth',2);
end
hold off
xlabel('Time'); ylabel('Population size N');
axis([0,8,0,min(max(y),100)]);
```

MATLAB Program for Exponential Growth: Markov Chain 10,000 Sample Paths to Estimate Probability of Extinction

```
% Numerical Check on Probability of Extinction
% for the exponential growth model
clear
x0=2; b=2; d=1.25; %Initial value and parameters
count=0;
for j=1:10000 % 10,000 sample paths
  clear n
  n=x0;
% Population size either hits zero or reaches 25
  while n>0 & n<25;
    r=rand;
    if r< b/(b+d)
       n=n+1; % Birth
    else
       n=n-1; % Death
    end
  end
% Count number sample paths that hit zero out of 10,000
   if n==0;
      count=count+1;
   end
end
probext=count/10000;
exact=(d/b)^(x0);
disp('  ');
disp('   x0     b      d    Approx Prob Extinct    Exact=(d/b)^x0')
disp((sprintf('%6.2f %6.2f %6.2f %14.4f %18.4f',x0,b,d,probext,exact)))
```