```
% sprfft - Program to compute the power spectrum of a
% coupled mass-spring system.
clear; help sprfft;  % Clear memory and print header

type sprrk.m

%* Set parameters for the system (initial positions, etc.).
x = [1, 0, 0, 0];
v = [0 0 0 0];       % Masses are initially at rest
state = [x v];     % Positions and velocities; used by rk4
tau = 0.002
k_over_m = 1;      % Ratio of spring const. over mass

%* Loop over the desired number of time steps.
time = 0;          % Set initial time
nstep = 256;       % Number of steps in the main loop
nprint = nstep/8;  % Number of steps between printing progress
for istep=1:nstep  %%% MAIN LOOP %%%

  %* Use Runge-Kutta to find new displacements of the masses.
  state = rk4(state,time,tau,'sprrk',k_over_m);
  time = time + tau;

  %* Record the positions for graphing and to compute spectra.
  xplot(istep,1:3) = state(1:3);   % Record positions
  tplot(istep) = time;
end

%* Graph the displacements of the three masses.
figure(1); clf;  % Clear figure 1 window and bring forward
ipr = 1:nprint:nstep;  % Used to graph limited number of symbols
plot(tplot(ipr),xplot(ipr,1),'o',tplot(ipr),xplot(ipr,2),'+',...
     tplot(ipr),xplot(ipr,3),'*',...
     tplot(ipr),xplot(ipr,4),'-.',...
     tplot,xplot(:,1),'-',tplot,xplot(:,2),'-.',...
     tplot,xplot(:,3),'--',...
     tplot,xplot(:,4),'---');
legend('Mass #1  ','Mass #2  ','Mass #3  ','Mass #4  ');
title('Displacement of masses (relative to rest positions)');
xlabel('Time'); ylabel('Displacement');
drawnow;

%* Calculate the power spectrum of the time series for mass #1
f(1:nstep) = (0:(nstep-1))/(tau*nstep);      % Frequency
x1 = xplot(:,1);              % Displacement of mass 1
x1fft = fft(x1);              % Fourier transform of displacement
spect = abs(x1fft).^2;        % Power spectrum of displacement

%* Apply the Hanning window to the time series and calculate
%  the resulting power spectrum
window = 0.5*(1-cos(2*pi*((1:nstep)-1)/nstep)); % Hanning window
x1w = x1 .* window';          % Windowed time series
```

```
x1wfft = fft(x1w);             % Fourier transf. (windowed data)
spectw = abs(x1wfft).^2;       % Power spectrum (windowed data)

%* Graph the power spectra for original and windowed data
figure(2); clf;  % Clear figure 2 window and bring forward
semilogy(f(1:(nstep/2)),spect(1:(nstep/2)),'-',...
         f(1:(nstep/2)),spectw(1:(nstep/2)),'--');
title('Power spectrum (dashed is windowed data)');
xlabel('Frequency'); ylabel('Power');
```

```
  sprfft - Program to compute the power spectrum of a
  coupled mass-spring system.


function deriv = sprrk(s,t,param)
%  Returns right-hand side of 3 mass-spring system
%  equations of motion
%  Inputs
%    s       State vector [x(1) x(2) ... v(3)]
%    t       Time (not used)
%    param   (Spring constant)/(Block mass)
%  Output
%    deriv   [dx(1)/dt dx(2)/dt ... dv(3)/dt]
deriv(1) = s(5);
deriv(2) = s(6);
deriv(3) = s(7);
deriv(4) = s(8);
param2 = -2*param;
A = [-2, 1, 1, 0; 1, -3, 1, 1; 1, 1, -3, 1; 0, 1, 1, -2];
b = [-2, -1, 1, 2]';
deriv(5:8) = A * s(1:4)' - b;
return;
end

tau =

    0.0020


Index in position 2 exceeds array bounds (must not exceed 3).

Error in sprfft (line 34)
     tplot(ipr),xplot(ipr,4),'-.',...
```

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