```matlab
1  function x = lsqrSOLtest( m, n, damp )
2
3  %        x = lsqrSOLtest(  m, n, damp);
4  %        x = lsqrSOLtest( 10,10, 0   );
5  %        x = lsqrSOLtest( 20,10, 0   );
6  %        x = lsqrSOLtest( 20,10, 0.1 );
7  %
8  % If m = n and damp = 0, this sets up a system Ax = b
9  % and calls lsqrSOL.m to solve it.  Otherwise, the usual
10 % least-squares or damped least-squares problem is solved.
11
12 % 11 Apr 1996: First version for distribution with lsqr.m.
13 % 07 Aug 2002: LSQR's output parameter rnorm changed to r1norm, r2norm.
14 % 03 May 2007: Allow A to be a matrix or a function handle.
15 %                Private function Aprodxxx defines matrix-vector products
16 %                for a specific A.
17 % 24 Dec 2010: A*v and A'*v use inputs (v,1) and (v,2), not (1,v) and (2,v).
18
19 %                Michael Saunders, Systems Optimization Laboratory,
20 %                Dept of MS&E, Stanford University.
21 %-------------------------------------------------------------------
22
23   A       = @(v,mode) Aprodxxx( v,mode,m,n );   % Nested function
24
25   xtrue  = (n : -1: 1)';
26   b       = A(xtrue,1);
27
28   atol   = 1.0e-6;
29   btol   = 1.0e-6;
30   conlim = 1.0e+10;
31   itnlim = 10*n;
32   show   = 1;
33
34   [ x, istop, itn, r1norm, r2norm, Anorm, Acond, Arnorm, xnorm, var ] ...
35      = lsqrSOL( m, n, A, b, damp, atol, btol, conlim, itnlim, show );
36
37   disp(' ');    j1 = min(n,5);    j2 = max(n-4,1);
38   disp('First elements of x:');  disp(x(1:j1)');
39   disp('Last  elements of x:');  disp(x(j2:n)');
40
41   r     = b - A(x,1);
42   r1    = norm(r);
43   r2    = norm([r; (-damp*x)]);
44   disp(' ')
45   str1 = sprintf( 'r1norm, r2norm (est.)  %10.3e %10.3e', r1norm, r2norm );
46   str2 = sprintf( 'r1norm, r2norm (true)  %10.3e %10.3e', r1    , r2     );
47   disp(str1)
48   disp(str2)
49
50   %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
51   % Nested functions (only 1 here).
52   %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
53
54   function y = Aprodxxx( x, mode, m, n )
55
56      % Private function.
```

```matlab
57        % if mode = 1, computes y = A*x
58        % if mode = 2, computes y = A'*x
59        % for some matrix  A.
60        %
61        % This is a simple example for testing  LSQR.
62        % It uses the leading m*n submatrix from
63        % A = [ 1
64        %       1 2
65        %         2 3
66        %           3 4
67        %             ...
68        %                 n ]
69        % suitably padded by zeros.
70        %
71        % 11 Apr 1996: First version for distribution with lsqr.m.
72        %              Michael Saunders, Dept of EESOR, Stanford University.
73
74        if mode == 1
75          d  = (1:n)';  % Column vector
76          y1 = [d.*x; 0] + [0;d.*x];
77          if m <= n+1
78        y = y1(1:m);
79          else
80        y = [      y1;
81          zeros(m-n-1,1)];
82          end
83        else
84          d  = (1:m)';  % Column vector
85          y1 = [d.*x] + [d(1:m-1).*x(2:m); 0];
86          if m >= n
87        y = y1(1:n);
88          else
89        y = [y1;
90          zeros(n-m,1)];
91          end
92        end

94      end % nested function Aprodxxx

96 end % function lsqrSOLtest
```