

```

clear
rng('default')
n = 30;
density = 0.15;
A = speye(n,n) + sprand(n, n, density);
m = 8;
b = rand(n,1);
[V, H, beta] = arnoldi(A, b, m); % a separate function that does the same thing
Hm = H(1:m, 1:m); Vm = V(:, 1:m);
e1 = [1; zeros(m-1,1)];
em = [zeros(m-1,1); 1];

```

```
[A*b, beta*Vm*Hm*e1] % equal
```

```

ans = 30x2
    1.0051    1.0051
    1.8226    1.8226
    1.3293    1.3293
    1.3228    1.3228
    2.2122    2.2122
    1.5880    1.5880
    1.1542    1.1542
    1.8844    1.8844
    1.0345    1.0345
    0.3087    0.3087
    ⋮
    ⋮

```

Hm

```

Hm = 8x8
    2.7434    0.4092   -0.0530    0.2367    0.0399   -0.0552   -0.1767   -0.6375
    1.4800    1.3279    0.0200    0.4796   -0.1490    0.0056   -0.1116   -0.2252
     0      0.8602    0.6963    0.2367   -0.0707    0.1158    0.4029   -0.2840
     0         0     1.0722    1.0947    0.0972   -0.0908    0.0599    0.2271
     0         0         0     1.1508    1.4591    0.1300    0.6966   -0.0018
     0         0         0         0     0.9379    0.8914   -0.2428   -0.1930
     0         0         0         0         0     1.0452    0.6943    0.0261
     0         0         0         0         0         0     0.9754    1.0924

```

```
[A^2*b, beta*Vm*Hm^2*e1] % equal
```

```

ans = 30x2
    3.1226    3.1226
    7.4722    7.4722
    3.9872    3.9872
    4.0638    4.0638
    7.9774    7.9774
    5.2837    5.2837
    2.8437    2.8437
    5.9191    5.9191
    4.1808    4.1808
    1.7199    1.7199
    ⋮
    ⋮

```

Hm^2

ans = 8×8

8.1317	1.6204	0.0797	1.1383	0.0819	-0.4054	-1.2407	-2.4626
6.0257	2.3863	0.4763	1.3457	-0.3057	-0.2465	-0.7751	-1.3890
1.2731	1.7413	0.7559	0.7552	-0.1490	0.5791	0.1242	-0.6596
0	0.9223	1.9203	1.5642	0.0874	0.0191	0.8505	0.2111
0	0	1.2339	2.9389	2.3627	0.9291	1.5357	0.2498
0	0	0	1.0794	2.2046	0.6628	0.0801	-0.3909
0	0	0	0	0.9803	1.6574	0.2538	-0.1551
0	0	0	0	0	1.0194	1.7427	1.2187

[A^3*b, beta*Vm*Hm^3*e1] % equal

ans = 30×2

9.1903	9.1903
25.5437	25.5437
11.9263	11.9263
12.9946	12.9946
26.1217	26.1217
16.3445	16.3445
7.8001	7.8001
19.7061	19.7061
15.1713	15.1713
7.3213	7.3213
⋮	

Hm^(m-2)

ans = 8×8

732.5801	185.2675	40.6614	120.4084	-35.7687	-89.8289	-146.8931	-237.1341
631.2516	163.2841	35.7137	104.5105	-28.9494	-72.3028	-123.9003	-202.8439
230.4496	65.0848	19.4628	47.8626	-4.2921	-22.0044	-40.4474	-73.2938
113.5420	43.3451	18.9493	35.5141	7.1321	0.8733	-12.1280	-35.2103
54.1358	43.0952	46.8533	70.5239	41.2713	28.7073	23.5740	-15.2188
12.1003	18.9133	29.5976	41.3834	24.4909	16.6999	19.0575	-2.3717
1.5399	6.4130	17.5551	28.9466	21.3332	9.8037	13.1172	-0.1381
0	1.0148	6.9937	18.5343	22.6336	12.1027	9.4906	-0.0738

[A^(m-1)*b, beta*Vm*Hm^(m-1)*e1] % equal

ans = 30×2

10³ ×

0.8050	0.8050
2.3312	2.3312
1.1331	1.1331
1.2183	1.2183
2.6942	2.6942
1.3816	1.3816
0.5979	0.5979
2.3630	2.3630
1.5413	1.5413
0.9135	0.9135
⋮	

```
Hm^(m-1)
```

```
ans = 8×8
```

```
103 ×
```

2.2839	0.5808	0.1223	0.3626	-0.1260	-0.2839	-0.4629	-0.7384
1.9734	0.5059	0.1067	0.3173	-0.1015	-0.2370	-0.3956	-0.6364
0.7285	0.1975	0.0540	0.1378	-0.0241	-0.0769	-0.1345	-0.2331
0.3756	0.1203	0.0461	0.0992	0.0114	-0.0180	-0.0531	-0.1184
0.2123	0.1197	0.1062	0.1693	0.0864	0.0519	0.0320	-0.0631
0.0612	0.0555	0.0647	0.0924	0.0510	0.0371	0.0341	-0.0163
0.0137	0.0242	0.0433	0.0638	0.0410	0.0246	0.0293	-0.0026
0.0015	0.0074	0.0248	0.0485	0.0455	0.0228	0.0232	-0.0002

```
[A^m*b, beta*Vm*Hm^m*e1] % not equal
```

```
ans = 30×2
```

```
103 ×
```

2.5083	2.5077
7.1556	7.1570
3.5061	3.5070
3.8243	3.8249
8.4855	8.4855
4.2276	4.2268
1.8481	1.8483
7.5469	7.5474
4.7875	4.7869
2.9034	2.9021
⋮	

```
[Vm'*A^m*b beta*Hm^m*e1] % equal
```

```
ans = 8×2
```

```
104 ×
```

1.9789	1.9789
1.7115	1.7115
0.6363	0.6363
0.3357	0.3357
0.2109	0.2109
0.0694	0.0694
0.0204	0.0204
0.0042	0.0042

```
p1 = [1 rand(1,m)]
```

```
p1 = 1×9
```

1.0000	0.8754	0.5181	0.9436	0.6377	0.9577	0.2407	0.6761	...
--------	--------	--------	--------	--------	--------	--------	--------	-----

```
p = charpoly(Hm)
```

```
p = 1×9
```

1.0000	-9.9996	41.3276	-93.8452	130.7083	-117.2833	70.0542	-28.5061	...
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```
rho1 = V(:,m+1)'.*polyvalm(p1, A)*b
```

```
rho1 =
```

4.3089

```
rho = V(:,m+1)'.*polyvalm(p, A)*b
```

```
rho =  
4.3089
```

```
beta * H(m+1,m)*em'*Hm^(m-1)*e1
```

```
ans =  
4.3089
```

```
beta * prod(diag(H,-1))
```

```
ans =  
4.3089
```

```
w1 = Vm'*polyvalm(p1, A)*b
```

```
w1 = 8×1  
104 ×  
2.7224  
2.3523  
0.8710  
0.4536  
0.2736  
0.0864  
0.0240  
0.0045
```

```
w = Vm'*polyvalm(p, A)*b
```

```
w = 8×1  
10-12 ×  
-0.0012  
0.0231  
-0.0055  
0.1064  
0.1622  
0.0882  
0.0783  
0.1119
```