C harmonic minor: C, D, E **♭,** F , G, A **♭**,B

G=voice\_leading\_graph([0,2,3,5,7,8,11])

Katz:

A=nx.adjacency\_matrix(G)

B=nl.eigvals(A)

B.sort()

B

Out[304]:

array([ -2.71602163e+00, -2.00000000e+00, -9.39688028e-01,

-6.18033989e-01, -4.43497799e-01, -2.90640381e-16,

8.79572964e-01, 1.45132791e+00, 1.61803399e+00,

2.76830658e+00])

katz=nx.katz\_centrality\_numpy(G,1.0/2.8)

katz

Out[306]:

{0: 0.27612570172044926,

1: 0.174208567811359,

2: 0.38134973755440565,

3: 0.30312293235199983,

4: 0.28273341551138814,

5: 0.30312293235199966,

6: 0.38134973755440565,

7: 0.4780781413714406,

8: 0.2827334155113881,

9: 0.1742085678113589}

{0: 'C-',

1: 'Do',

2: 'D#^',

3: 'F-',

4: 'Fo',

5: 'G+',

6: 'G#+',

7: 'G#-',

8: 'G#o',

9: 'Bo'})]

"""

Communicability of all pairs:

**nx.communicability(G)**

**Out[5]:**

**{0: {0: 2.528439311313303,**

**1: 0.3274159290592279,**

**2: 2.1842816151383593,**

**3: 0.9978645488843814,**

**4: 0.7521293010196735,**

**5: 0.9978645488843815,**

**6: 2.1842816151383593,**

**7: 1.8586452835564755,**

**8: 0.752129301019673,**

**9: 0.32741592905922806},**

**1: {0: 0.3274159290592279,**

**1: 2.3432388803890927,**

**2: 0.42463446358776746,**

**3: 1.8679484552034147,**

**4: 0.8321041072496986,**

**5: 0.8056488232812439,**

**6: 0.9006460143558408,**

**7: 0.6303390932788758,**

**8: 0.3560925564816243,**

**9: 1.6216155159983834},**

**2: {0: 2.1842816151383593,**

**1: 0.42463446358776746,**

**2: 3.507458208647318,**

**3: 0.8627578312635091,**

**4: 1.113271279450192,**

**5: 2.4010690139537503,**

**6: 1.8774909351068416,**

**7: 2.936410916158031,**

**8: 1.7432385529906662,**

**9: 0.900646014355841},**

**3: {0: 0.9978645488843814,**

**1: 1.8679484552034147,**

**2: 0.8627578312635091,**

**3: 3.2703401787133872,**

**4: 2.1421949920006673,**

**5: 0.5343940808643632,**

**6: 2.40106901395375,**

**7: 1.883138048396055,**

**8: 0.6038838093104244,**

**9: 0.8056488232812461},**

**4: {0: 0.7521293010196735,**

**1: 0.8321041072496986,**

**2: 1.113271279450192,**

**3: 2.1421949920006673,**

**4: 2.5781355668690797,**

**5: 0.6038838093104256,**

**6: 1.7432385529906662,**

**7: 2.443155637091443,**

**8: 0.9481682933286046,**

**9: 0.3560925564816267},**

**5: {0: 0.9978645488843815,**

**1: 0.8056488232812439,**

**2: 2.4010690139537503,**

**3: 0.5343940808643632,**

**4: 0.6038838093104256,**

**5: 3.2703401787133854,**

**6: 0.8627578312635089,**

**7: 1.8831380483960563,**

**8: 2.1421949920006664,**

**9: 1.867948455203413},**

**6: {0: 2.1842816151383593,**

**1: 0.9006460143558408,**

**2: 1.8774909351068416,**

**3: 2.40106901395375,**

**4: 1.7432385529906662,**

**5: 0.8627578312635089,**

**6: 3.507458208647317,**

**7: 2.9364109161580307,**

**8: 1.113271279450191,**

**9: 0.4246344635877679},**

**7: {0: 1.8586452835564755,**

**1: 0.6303390932788758,**

**2: 2.936410916158031,**

**3: 1.883138048396055,**

**4: 2.443155637091443,**

**5: 1.8831380483960563,**

**6: 2.9364109161580307,**

**7: 4.499675644242483,**

**8: 2.4431556370914436,**

**9: 0.6303390932788765},**

**8: {0: 0.752129301019673,**

**1: 0.3560925564816243,**

**2: 1.7432385529906662,**

**3: 0.6038838093104244,**

**4: 0.9481682933286046,**

**5: 2.1421949920006664,**

**6: 1.113271279450191,**

**7: 2.4431556370914436,**

**8: 2.5781355668690797,**

**9: 0.8321041072496969},**

**9: {0: 0.32741592905922806,**

**1: 1.6216155159983834,**

**2: 0.900646014355841,**

**3: 0.8056488232812461,**

**4: 0.3560925564816267,**

**5: 1.867948455203413,**

**6: 0.4246344635877679,**

**7: 0.6303390932788765,**

**8: 0.8321041072496969,**

**9: 2.3432388803890922}}**

**Each with itself: 0: {0: 2.528439311313303,**

**1: 2.3432388803890927,**

**2: 3.507458208647318,**

**3: 3.2703401787133872,**

**4: 2.5781355668690797,**

**5: 3.2703401787133854,**

**6: 3.507458208647317**

**7: 4.499675644242483,**

**8: 2.5781355668690797,**

**9: 2.3432388803890922}**

**BETWEENNESS CENTRALITY**

**nx.betweenness\_centrality(G)**

**Out[6]:**

**{0: 0.0324074074074074,**

**1: 0.1111111111111111,**

**2: 0.1574074074074074,**

**3: 0.1898148148148148,**

**4: 0.05092592592592592,**

**5: 0.1898148148148148,**

**6: 0.1574074074074074,**

**7: 0.25462962962962954,**

**8: 0.05092592592592592,**

**9: 0.1111111111111111}**