CSS - 674
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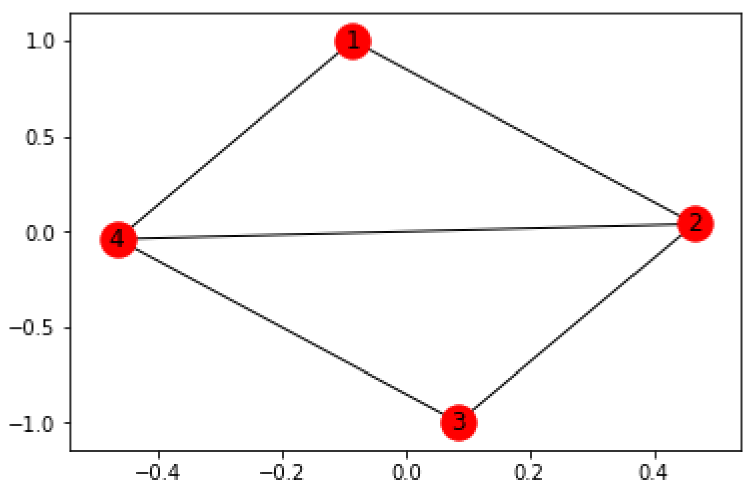
Assignment 1

Copied code from assignment to implement G

In [2]:
```
import networkx as nx
import random
G=nx.Graph()
G.add_node(1)
G.add_node(2)
G.add_node(3)
G.add_node(4)
G.add_edge(1,2)
G.add_edge(1,4)
G.add_edge(2,4)
G.add_edge(2,3)
G.add_edge(3,4)
nx.draw_networkx(G)
```



In [3]:
```
print(G.degree(1))
print(list(G.neighbors(1)))
print(G.has_edge(1,2))
```

```
2
[2, 4]
True
```

In [4]:
```
def hypot_len(x,y):
    h2 = x**2+y**2
    h = h2**0.5
    return(h)

print(hypot_len(3,4))

def m(H):
    s=0
    for i in H.nodes():
        s=s+H.degree(i)
    s=s/2
    return(s)

print(m(G))
print(G.size())
print(G.order())
print(list(G.nodes()))
print(list(G.edges()))
VG = list(G.nodes())
EG = list(G.edges())
VG[0]
VG[3]
```

```
5.0
5.0
5
4
[1, 2, 3, 4]
[(1, 2), (1, 4), (2, 4), (2, 3), (3, 4)]
```

Out[4]: 4

In [5]:
```
A=nx.adjacency_matrix(G)
A[0,1]
```

Out[5]: 1

Task 1:

Create a function that takes in G, i, and j and returns 1 if a link exists and 0 otherwise.

In [6]:
```
def link_indicator(G,i,j):
    if (i,j) in G.edges() or (j,i) in G.edges():
        return(1)
    else:
        return(0)

link_indicator(G,1,3)
```

Out[6]: 0

Task 2:

Using the link indicator from Task 1, create a function that takes input G and a node and returns the degree of that node.

In [7]:
```
def degree(G,i):
    c = 0
    for iter in G.edges():
        if i in iter:
            c+=1
    return(c)

degree(G,4)
```

Out[7]: 3

Task 3:

Create two functins that take G as an input and generate a printed output of each node and its degree. Once function should use **degree** from networkx and the other should use the function from task 2.

In [8]:
```
def all_degrees_1(G):
    print("%6s %6s"%("Node","Degree"))
    for i in G:
        print("%6d %6d" % (i,degree(G,i))) #my degree functino

def all_degrees_2(G):
    print("%6s %6s"%("Node","Degree"))
    for  i in G:
        print("%6d %6d" % (i,G.degree(i))) #degree function from nx for
 class G

all_degrees_1(G) # using bespoke functions
all_degrees_2(G) # using networkx functions
```

```
  Node Degree
     1      2
     2      3
     3      2
     4      3
  Node Degree
     1      2
     2      3
     3      2
     4      3
```

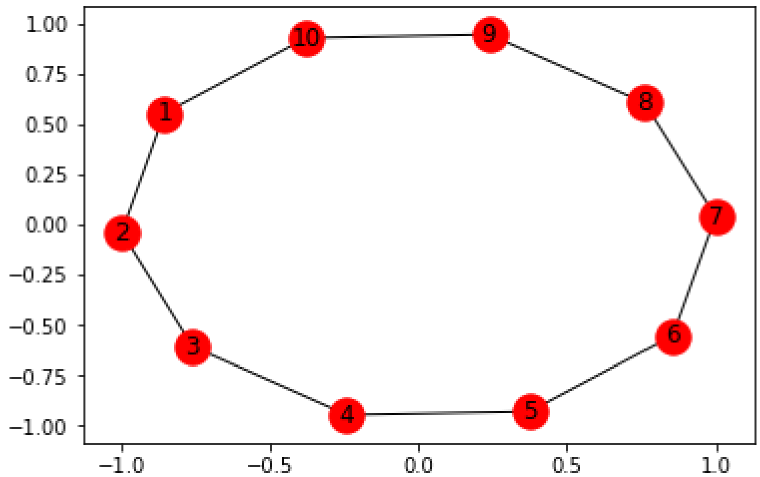
Task 4:

Craete a function that creates ring graphs from input n.

In [9]:
```
def create_ring(n):
    new_g = nx.Graph()
    for i in range(1,n):
        new_g.add_edge(i,i+1)
    new_g.add_edge(1,n)
    return(new_g)

G2 = create_ring(10)
nx.draw_networkx(G2)

def verify_ring(G):
    is_ring = True
    EG = G.edges()
    VG = G.nodes()
    if len(EG) != len(VG):     #verify m and n are equal
        is_ring = False
    for i in range(0,10):      #verify degree of 10 randomly selected nod
es ==2
        node = random.randint(1,len(VG))
        if G.degree(node) != 2:
            is_ring = False
    return(is_ring)

def verify_ring_creator():
    """This function creates 10 networks with n*100 nodes
    using the ring creator function, then verifies they
    are  rings by caling the verify ring function"""
    func_ok = True
    for i in range(1,11):
        temp_G = create_ring(i*1000)
        temp_G_state = verify_ring(temp_G)
        print(i*1000,temp_G_state)
        if temp_G_state is False:
            func_ok = False
    return(func_ok)

verify_ring(G2)
verify_ring_creator()
```

```
1000 True
2000 True
3000 True
4000 True
5000 True
6000 True
7000 True
8000 True
9000 True
10000 True
```

Out[9]: True



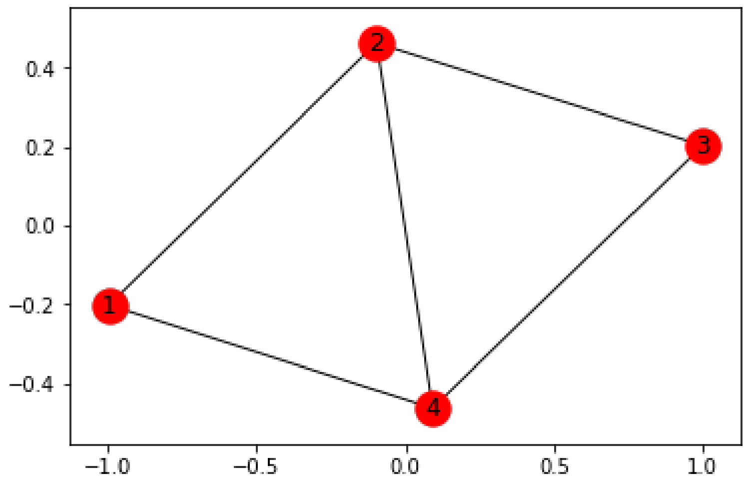
Task 5:

Create 2 functions that take graph G and node i as inputs and return the number of Vs that visit the node. One function should use nx.Graph() and the other should use the degree function in task 2.

After reaching Task 7, I believe I may have misunderstood the ask. I calculated all Vs that have the target node in any position, not merely the vertex. I have added additional functions that, count_V3 and count_V4, that only count the Vs when the target node is the vertex.

In [10]:
```
def count_V1(G,i):
    i_n = list(G.neighbors(i))     # This version usess my degree functio
n
    v = 0
    for iterable in i_n:
        v += degree(G,iterable)-1 #add all Vs ending at i
    i_d = degree(G,i)
    v += (i_d*(i_d-1)) / 2         #add all Vs with i as vertex
    return(v)

def count_V2(G,i):
    i_n = list(G.neighbors(i))
    v = 0
    for iterable in i_n:
        v += G.degree(iterable)-1
    i_d = G.degree(i)
    v += (i_d*(i_d-1)) / 2
    return(v)

def count_V3(G,i):
    i_d = degree(G,i)
    v = i_d * (i_d-1)
    return(v)

def count_V4(G,i):
    i_d = G.degree(i)
    v = i_d * (i_d-1)
    return(v)

G2 = create_ring(101)   # create a ring network with < 100 nodes
                        # 101 is the minimum viable count
nx.draw_networkx(G)
print(count_V1(G,2))
print(count_V2(G,2))
print(count_V3(G,2))
print(count_V4(G,2))
print(count_V1(G2,50))
print(count_V2(G2,50))
print(count_V3(G2,50))
print(count_V4(G2,50))
```

```
7.0
7.0
6
6
3.0
3.0
2
2
```



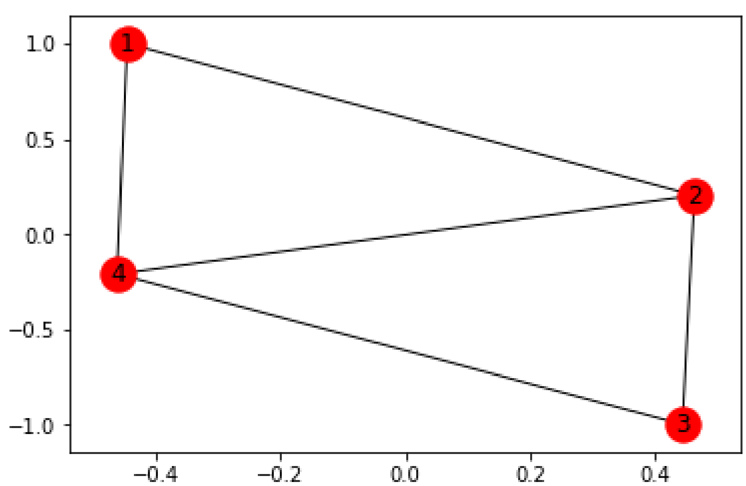
Task 6:

Create a function that takes graph G and node i as input and determine the number of triangles that visit i.

Note: I may not have followed this as intended; I am returning the triangles such that $t = \{i, j, k\}$ where edges $(i, j), (j, k), (k, i)$ exist. In other words, I am only counting triangles where the set of nodes is unique from any other counted triangle.

In [11]:
```python
def count_triangles(G,node):
    i_n = list(G.neighbors(node))
    t   = 0
    for i in i_n:
        for j in i_n:
            if i<j:
                if G.has_edge(i,j):
                    t +=1
    return(t)



def count_triangles2(G,node):
    A   = nx.adjacency_matrix(G)
    i_n = list(G.neighbors(node))
    t   = 0
    for i in i_n:
        for j in i_n:
            if i<j:
                if A[i-1,j-1]:
                    t  +=1
    return(t)

nx.draw_networkx(G)
print(count_triangles(G,1))
print(count_triangles2(G,1))
print(count_triangles(G,2))
print(count_triangles2(G,2))
print()
print(count_triangles(G2,50))
print(count_triangles2(G2,50))
```

```
1
1
2
2

0
0
```



Task 7:

Create a function that takes graph G and node i as input and retturns the local clustering of node i. Use functions from 5 and 6.

$$c_i = \frac{2t_i}{k_i(k_i - 1)}$$

Note that the functions written in task 5 already contain the complete numerator, while the function from task 6 is exactly t_i and thus should be multiplied by 2. See also, note from Task 6.

In [12]:
```
def local_cluster(G,node):
    t  = 2*count_triangles(G,node)
    vs = count_V3(G,node)
    c  = t/vs
    return(c)

print(local_cluster(G,1))
print(nx.clustering(G,1))
print(local_cluster(G,2))
print(nx.clustering(G,2))
print()
print(local_cluster(G2,50))
print(nx.clustering(G2,50))
```

```
1.0
1.0
0.6666666666666666
0.6666666666666666

0.0
0
```

Task 8:

Create a function that takes graph G as an input and determines the global clustering of the network. Use functions from task 5 and tasks 6.

In [13]:
```
def global_clustering(G):
    v_g = G.nodes()
    c   = 0
    t   = 0
    vs  = 0
    for i in v_g:
        t += 2*count_triangles(G,i)
        vs+= count_V3(G,i)
    c = t/vs
    return(c)

print(global_clustering(G))
print(nx.transitivity(G))
print()
print(global_clustering(G2))
print(nx.transitivity(G2))
```

```
0.75
0.75

0.0
0
```