Que1:

(a) Represent the network in terms of its 'adjacency matrix' as well as 'edge list'.

In [55]:
```
# libereraies added
import numpy as np
import operator
from collections import Counter
import matplotlib.pyplot as plt
```

In [56]:
```
import pandas as pd
data = pd.read_csv('fb-pages-food.edges', sep=',') #data loadede here int the
 form of data frame: undirected dataset
```

In [57]:
```
data.columns=["u","v"]  #two columns name u and v both were nodes
data
```

Out[57]:

	u	v
0	0	58
1	0	132
2	0	603
3	0	398
4	0	555
...	...	...
2096	597	611
2097	601	603
2098	601	616
2099	603	616
2100	311	613

2101 rows × 2 columns

total number of nodes: 620

count total number of nodes in graph

In [58]:
```
n=set(data['u']).union(set(data['v']))
print("total number of nodes: ",len(n))
```

```
total number of nodes:  620
```

Adjancecy matix of size n by n with 0 initlaization.

In [59]:
```
# https://stackoverflow.com/questions/2397141/how-to-initialize-a-two-dimensional-array-in-python
adjancency_matrix= [[0 for i in range(len(n))] for j in range(len(n))]    #adjancecey matrix
```

fill up the matrix if there is an edge between node u and node v then put 1 in matrix block between matrix[u][v] else assign 0 in them

In [60]:
```
for i in range(0,len(data)):   #loop till o to total edges in the graph and fill the matrix
  if(data['u'][i]!=data['v'][i]):   # check for 2 nodes should't be same else self loop will occure no require for that
     adjancency_matrix[data['u'][i]][data['v'][i]]=1     #assign 1 is there us edge
     adjancency_matrix[data['v'][i]][data['u'][i]]=1     # else 0
```

Adjancecy matrix of graph

In [61]:
```
import pprint
pp = pprint.PrettyPrinter(indent=10)
pp.pprint(np.array(adjancency_matrix))
```

```
array([[0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       ...,
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0],
       [0, 0, 0, ..., 0, 0, 0]])
```

Create an edge list for all the nodes of the graph:

In [62]:
```
edge_list={}   # dictionary for edge list
for i in range(len(adjancency_matrix)): # initialise empty list for all the nodes
  edge_list[i]=[]
```

In [63]:
```
total_edges=0    #total edges are 0 intitia;;y
degree_of_nodes={}   # dictionary for degree of each node where key is node an
d value is degree of particular node.
for i in range(len(adjancency_matrix)):  # loop for rows
  for j in range(len(adjancency_matrix[i])): #loop for columns
    if adjancency_matrix[i][j]==1:      #check is there is an edge in graph
      edge_list[i].append(j)                # then append it on the list of pa
rticular node
  degree_of_nodes[i]=len(edge_list[i])       #here total number of nodes prese
nt in the list of nodes of edge list i.e.total neighbors is the degree of a pa
rticular node.
  total_edges+=len(edge_list[i])             #here counting of total edges
  print(i,"------",edge_list[i])
```

```
0 ------ [58, 132, 398, 555, 603]
1 ------ [265, 611]
2 ------ [182, 265, 345]
3 ------ [40, 65, 185, 228, 299, 352, 377, 450, 484, 608]
4 ------ [254, 265, 287, 336]
5 ------ [503]
6 ------ [163, 429, 478, 486, 518]
7 ------ [35, 265, 293, 305, 339, 444, 583]
8 ------ [73, 98, 278, 369, 434]
9 ------ [15, 23, 56, 67, 89, 90, 107, 131, 189, 206, 229, 248, 249, 254, 26
5, 288, 289, 317, 340, 351, 434, 446, 465, 498, 550, 570, 593, 611]
10 ------ [258, 393]
11 ------ [174, 212, 259, 264, 380, 485]
12 ------ [310, 548, 618]
13 ------ [352]
14 ------ [264, 326]
15 ------ [9, 43, 56, 67, 70, 265, 340, 432, 454, 505]
16 ------ [75, 117, 119, 237, 274, 334, 374, 400, 466, 516, 545, 613]
17 ------ [65, 185, 299, 450, 608]
18 ------ [265]
19 ------ [572]
20 ------ [160, 238, 242, 324, 355, 481]
21 ------ [329, 334, 441, 516]
22 ------ [104, 187, 270, 420]
23 ------ [9, 54, 58, 67, 128, 157, 182, 227, 257, 277, 288, 340, 343, 434]
24 ------ [230, 306, 501, 502, 547, 591]
25 ------ [363]
26 ------ [230]
27 ------ [424]
28 ------ [147, 230, 527]
29 ------ [49]
30 ------ [126]
31 ------ [41, 48, 63, 142, 169, 179, 193, 266, 269, 285, 315, 327, 357, 424,
449, 488, 491, 507, 508, 515, 518, 524, 543, 546, 595]
32 ------ [89, 159, 183, 265, 300, 364, 581, 611]
33 ------ [209, 490]
34 ------ [89, 208, 254, 265, 373, 419]
35 ------ [7, 56, 58, 87, 89, 90, 131, 195, 198, 243, 265, 289, 338, 383, 38
9, 439, 536, 597, 601, 611, 615, 618]
36 ------ [490]
37 ------ [389]
38 ------ [518]
39 ------ [43, 250, 340, 509, 576, 603]
40 ------ [3, 240, 333, 344, 352, 484, 538]
41 ------ [31, 62, 109, 121, 193, 265, 282, 321, 397, 434, 465, 594, 611]
42 ------ [467]
43 ------ [15, 39, 67, 83, 102, 229, 253, 265, 340, 360, 505, 577]
44 ------ [265]
45 ------ [63, 191, 357, 461, 518, 524]
46 ------ [67, 86, 110, 317, 417, 550, 578]
47 ------ [475, 500, 508]
48 ------ [31, 164, 357, 518, 524]
49 ------ [29, 71, 188, 196, 293, 512]
50 ------ [67, 70, 131, 171, 182, 183, 289, 330, 340, 389, 483, 544, 562, 57
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51 ------ [141]
52 ------ [113, 494]
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55 ------ [78, 154, 158, 210, 214, 252, 437, 452]
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59 ------ [116, 265]
60 ------ [56, 198, 265, 350, 389, 439]
61 ------ [244]
62 ------ [41, 169, 193, 265, 266, 269, 282, 285, 392, 449, 611]
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64 ------ [498]
65 ------ [3, 17, 185, 240, 299, 333, 450, 608]
66 ------ [141]
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69 ------ [253, 385, 498]
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616]
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72 ------ [70, 240, 269]
73 ------ [8, 369]
74 ------ [98]
75 ------ [16, 117, 119, 237, 274, 334, 400, 516, 613]
76 ------ [483]
77 ------ [379]
78 ------ [55, 154, 158, 210, 214, 252, 331, 437, 452]
79 ------ [85, 357, 414, 491, 507, 518, 546, 595]
80 ------ [138]
81 ------ [290, 563]
82 ------ [171, 261, 389, 409, 451, 584]
83 ------ [43, 89, 254, 265, 288, 317, 465]
84 ------ [329, 374, 545]
85 ------ [79, 292, 335, 507, 518]
86 ------ [46, 578]
87 ------ [35, 56, 58, 89, 90, 131, 151, 175, 182, 198, 217, 227, 229, 257, 2
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92 ------ [186]
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94 ------ [93, 103]
95 ------ [492, 523]
96 ------ [211, 379, 537]
97 ------ [265]
98 ------ [8, 74, 99, 216, 295, 471, 605]
99 ------ [98, 108, 142, 431]
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101 ------ [124, 152, 216, 311, 329, 374, 545]
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111 ------ [229, 265, 389, 451]
112 ------ [265, 498]
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115 ------ [145, 485]
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123 ------ [179, 292, 347, 491, 518, 524]
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125 ------ [308, 423, 565]
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127 ------ [347, 357, 518, 524]
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139 ------ [63, 518]
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143 ------ [114, 134, 151, 172, 182, 184, 265, 397, 407, 408, 456, 580, 581]
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161 ------ [265]
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171 ------ [50, 82, 202, 406, 459]
172 ------ [143, 265, 581, 599, 611]
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175 ------ [87, 195, 265, 576, 611]
176 ------ [164, 216, 220, 301, 362, 427, 478, 497]
177 ------ [350, 389, 510]
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184 ------ [114, 134, 143, 251, 397, 456]
185 ------ [3, 17, 65, 240, 333, 356, 377, 432, 538]
186 ------ [92, 202, 414, 459]
187 ------ [22, 104, 217, 270, 420, 514]
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190 ------ [393]
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192 ------ [371, 559]
193 ------ [31, 41, 62, 146, 273, 282, 285, 433, 449]
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203 ------ [345, 435]
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205 ------ [70]
206 ------ [9, 90, 473]
207 ------ [372]
208 ------ [34, 90, 128, 136, 288, 340, 343, 446, 455, 601]
209 ------ [33, 180]
210 ------ [55, 78, 154, 158, 223, 252, 437, 452]
211 ------ [96]
212 ------ [11, 174, 259, 264, 380, 485]
213 ------ [502]
214 ------ [55, 78, 154, 158, 223, 533, 534]
215 ------ [204, 278, 405, 540]
216 ------ [98, 101, 176, 402, 618]
217 ------ [56, 87, 89, 90, 102, 130, 131, 187, 195, 198, 229, 245, 265, 289,
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219 ------ [548]
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221 ------ [89, 265]
222 ------ [113, 365, 494, 522]
223 ------ [154, 158, 210, 214, 252, 452, 542]
224 ------ [235, 244, 248, 258, 262, 352, 363, 376, 388, 443, 470, 517, 526,
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226 ------ [194, 371, 431]
227 ------ [23, 87, 90, 102, 121, 135, 195, 265, 352, 370, 436, 442, 453, 55
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231 ------ [425]
232 ------ [134, 146, 253, 498, 563]
233 ------ [265]
234 ------ [618]
235 ------ [56, 70, 181, 224, 244, 258, 352, 354, 363, 368, 472, 517, 526, 55
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236 ------ [282]
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241 ------ [145, 264, 485]
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257 ------ [23, 87, 157, 195, 265, 616]
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259 ------ [11, 174, 212, 264, 485]
260 ------ [294, 386, 432, 458]
261 ------ [82, 265, 397, 436, 451]
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263 ------ [311, 613]
264 ------ [11, 14, 57, 145, 174, 212, 241, 259, 318, 380, 485, 525]
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276 ------ [113, 149, 296, 398, 494, 555, 598, 619]
277 ------ [23, 265]
278 ------ [8, 215]
279 ------ [147, 230, 501]
280 ------ [141]
281 ------ [135, 404]
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283 ------ [350]
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285 ------ [31, 62, 193, 282]
286 ------ [368, 499]
287 ------ [4, 303]
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294 ------ [260]
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296 ------ [276]
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299 ------ [3, 17, 65, 168, 240, 272, 356, 377, 538, 575, 577]
300 ------ [32, 89, 182, 265, 303, 564, 581, 611]
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302 ------ [58, 265, 536]
303 ------ [287, 300, 336]
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306 ------ [24, 230, 547]
307 ------ [164, 292, 335, 357, 518, 524]
308 ------ [125, 555]
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312 ------ [265, 389]
313 ------ [357, 488, 518, 524]
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316 ------ [199, 518]
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319 ------ [113, 149, 365, 398, 494, 522, 559, 619]
320 ------ [109, 181, 265]
321 ------ [41, 135, 265, 389, 404]
322 ------ [245, 265]
323 ------ [67, 70, 162, 242, 253, 288, 340, 434, 498, 550, 593, 610]
324 ------ [20, 89, 90, 265, 317, 372, 422, 611, 616]
325 ------ [67, 131, 238, 289, 505]
326 ------ [14]
327 ------ [31, 164, 480, 518]
328 ------ [292, 491, 508, 518, 524, 596]
329 ------ [21, 84, 101, 137, 150, 152, 311, 374, 382, 441, 545, 609]
330 ------ [50, 436]
331 ------ [78, 154, 180]
332 ------ [494]
333 ------ [40, 65, 185]
334 ------ [16, 21, 75, 117, 119, 237, 274, 374, 400, 466, 516, 545, 613]
335 ------ [85, 292, 307, 357, 414, 518]
336 ------ [4, 303]
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346 ------ [265, 599]
347 ------ [123, 127, 179, 488, 518, 524, 543]
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618 ------ [12, 35, 216, 234, 393, 471]
619 ------ [194, 276, 319, 522, 555]
```

(c)Comment on the 'sparseness' of the network.

As there is no self loops the maximum number possile eges present in the graph is n(n-1)/2 where n is number of nodes in the graph here n*n(n-1)/2 is 191890 which is too much coampre to current present edges that is 2090 . So graph is highly sparse because of less number of edges present. here.

In [64]:
```
print("overall there are n*(n-1)/2 edges in the graph where value of n(nodes)
 is : ",len(n))
a=int((len(n)*(len(n)-1))/2)
print("therefor n*(n-1)/2 vlaue is : ",a)
b=int(total_edges/2)
print("Actual number of edges with ",len(n)," nodes are : ",b)
print("difference between : maximum edges - actual edges : ",(a-b))
print("therefor the graph is too sparse")
```

```
overall there are n*(n-1)/2 edges in the graph where value of n(nodes) is :
620
therefor n*(n-1)/2 vlaue is :  191890
Actual number of edges with  620  nodes are :  2090
difference between : maximum edges - actual edges :  189800
therefor the graph is too sparse
```

(d) Compute its average degree < k >.

In [65]:
```
print("Degree of each nodes are : ")
pp.pprint(degree_of_nodes)
val=0
for key,value in degree_of_nodes.items():   #here count of frquency of degrees
in degree_of_nodes dictionary where key is degree and values if frquency
  val+=value
print("average degree: ",val/len(n))   #here avergae dgeree is taken out by fo
rmula :total value sum of degrees/total nodes
```

```
Degree of each nodes are :
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          2: 3,
          3: 10,
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          6: 5,
          7: 7,
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442: 3,
443: 2,
444: 3,
445: 5,
446: 20,
447: 2,
448: 8,
449: 11,
450: 7,
451: 7,
452: 8,
453: 2,
454: 4,
```

```
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456: 7,
457: 2,
458: 10,
459: 8,
460: 6,
461: 3,
462: 1,
463: 3,
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465: 16,
466: 8,
467: 4,
468: 1,
469: 8,
470: 4,
471: 2,
472: 2,
473: 7,
474: 4,
475: 1,
476: 4,
477: 1,
478: 10,
479: 7,
480: 3,
481: 1,
482: 1,
483: 3,
484: 3,
485: 10,
486: 3,
487: 2,
488: 6,
489: 1,
490: 2,
491: 15,
492: 1,
493: 1,
494: 12,
495: 3,
496: 1,
497: 3,
498: 33,
499: 3,
500: 2,
501: 9,
502: 7,
503: 2,
504: 3,
505: 35,
506: 1,
507: 6,
508: 8,
509: 3,
510: 6,
511: 1,
```

```
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513: 1,
514: 1,
515: 6,
516: 13,
517: 5,
518: 59,
519: 2,
520: 1,
521: 5,
522: 11,
523: 2,
524: 29,
525: 3,
526: 17,
527: 7,
528: 1,
529: 3,
530: 2,
531: 5,
532: 2,
533: 2,
534: 1,
535: 6,
536: 10,
537: 2,
538: 6,
539: 3,
540: 3,
541: 1,
542: 1,
543: 6,
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546: 7,
547: 9,
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558: 13,
559: 4,
560: 1,
561: 1,
562: 1,
563: 13,
564: 1,
565: 2,
566: 4,
567: 3,
568: 3,
```

```
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 570: 14,
 571: 4,
 572: 5,
 573: 1,
 574: 2,
 575: 2,
 576: 17,
 577: 9,
 578: 10,
 579: 3,
 580: 8,
 581: 8,
 582: 1,
 583: 4,
 584: 15,
 585: 4,
 586: 1,
 587: 4,
 588: 2,
 589: 2,
 590: 1,
 591: 5,
 592: 1,
 593: 14,
 594: 2,
 595: 6,
 596: 8,
 597: 23,
 598: 5,
 599: 8,
 600: 1,
 601: 22,
 602: 3,
 603: 27,
 604: 2,
 605: 5,
 606: 1,
 607: 1,
 608: 7,
 609: 3,
 610: 2,
 611: 47,
 612: 4,
 613: 16,
 614: 1,
 615: 3,
 616: 23,
 617: 3,
 618: 6,
 619: 5}
average degree:  6.741935483870968
```

(e) Plot its 'scaled degree distribution', pk × k.

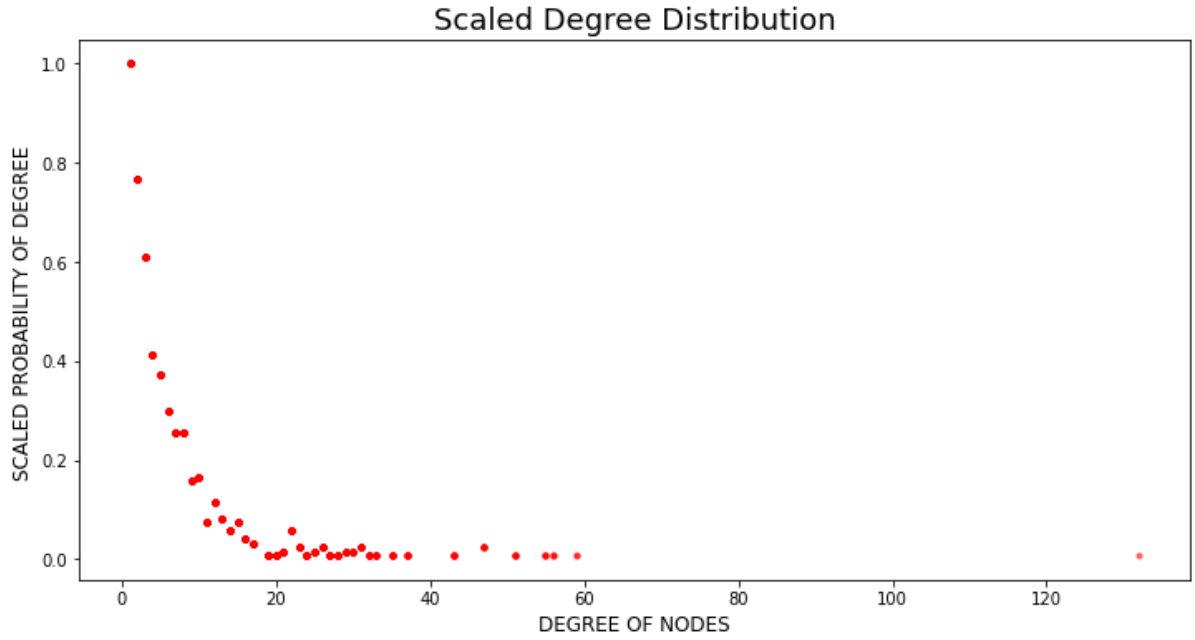
In [66]:
```
degree_frequncy={} # here frquncy count of each degree in degree_frequncy
for key,value in degree_of_nodes.items():
  if value not in degree_frequncy.keys():   #if particular frquncy is not arri
ved then put it there
    degree_frequncy[value]=0
    degree_frequncy[value]+=1
  else:
    degree_frequncy[value]+=1     ##here is particular degree is repeating the
n keep it counting
```

In [67]:
```
kmax=0
cmax=0
for key,value in degree_frequncy.items(): #for finding maximum degree kmax in
 the graph
  if cmax< value:
    kmax=key
    cmax=value
```

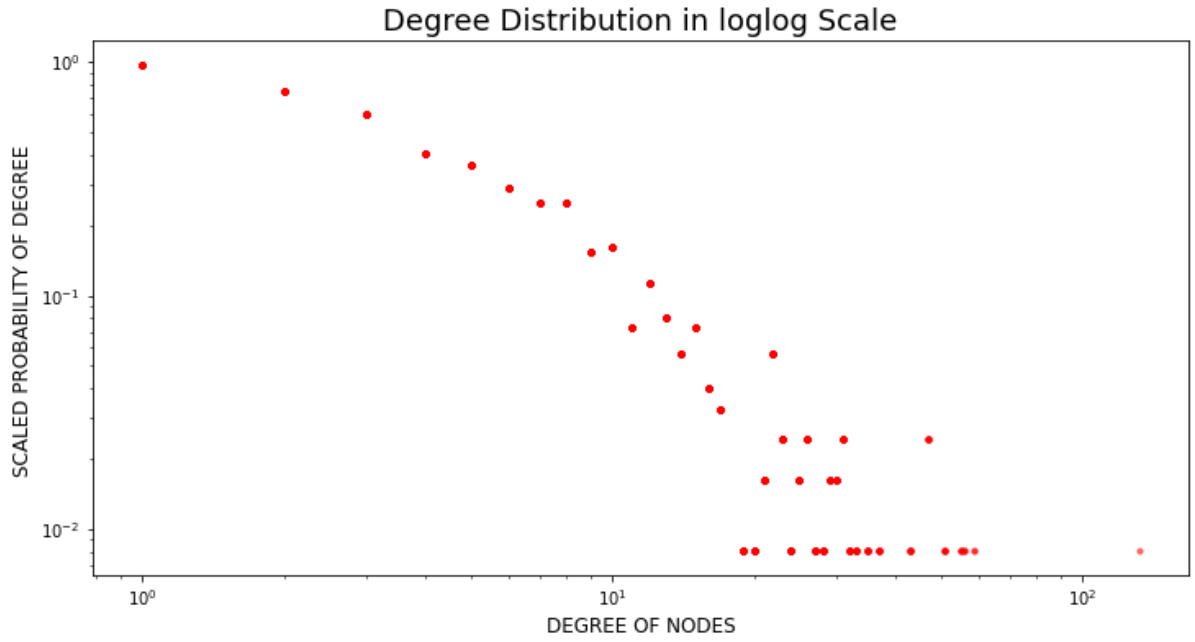
In [68]:
```
keyMax = degree_frequncy[max(degree_frequncy.items(), key = operator.itemgette
r(1))[0] ]
```

In [69]:
```
degree_frequncy = dict(sorted(degree_frequncy.items(), key=lambda x: x[0]))
```

In [70]:
```
import matplotlib.pyplot as plt
import numpy as np
fg, ax = plt.subplots(figsize =(12, 6))
x_axis=[]
y_axis=[]
kmax=max(list(degree_frequncy.keys()))
for key,value in  degree_frequncy.items():
  x_axis.append(key)
  y_axis.append((value/keyMax))
  ax.scatter(x_axis,y_axis,s=np.pi*3.2,c=("red"), alpha=0.5)

plt.xlabel("DEGREE OF NODES", fontsize=12)
plt.ylabel("SCALED PROBABILITY OF DEGREE ", fontsize=12)
plt.title("Scaled Degree Distribution",fontsize=18)
plt.show()
```



In [71]:
```
#Loglog Scaled Degree Distribution

import matplotlib.pyplot as plt
import numpy as np
fg, ax = plt.subplots(figsize =(12, 6))
x_axis=[]
y_axis=[]
for key,value in  degree_frequncy.items():
  x_axis.append(key)
  y_axis.append((value/len(n))/0.2)
  ax.scatter(x_axis,y_axis,s=np.pi*3.2,c=("red"), alpha=0.5)
  plt.yscale('log')
  plt.xscale('log')

plt.xlabel("DEGREE OF NODES", fontsize=12)
plt.ylabel("SCALED PROBABILITY OF DEGREE ", fontsize=12)
plt.title("Degree Distribution in loglog Scale",fontsize=18)
plt.show()
```



(f) Compute its Average Path Length (Implement Breadth First Search Algorithm), Diameter and Average Clustering Coefficient.

In [72]:
```
distance={}  #distance dictionary for storing of distance form src node(i) to
 destination node(j)
for i in range(0,len(adjancency_matrix)):  #initialization of distance matrix
 by 0 for all nodes
  distance[i]={}
  for j in range(0,len(adjancency_matrix[0])):
    distance[i][j]=0
```

Implement Breadth First Search Algorithm

In [73]:
```
# edge_list
sum=0
for i in range(0,len(adjancency_matrix)):  #loop for rows
  for j in range(i+1,len(adjancency_matrix)): #loop for columns
    if i!=j:  #if nodes are not same then start the algorithm
      temp={}  #temporary dictionary for assigneding distance of all the neigh
bor nodes of source node
      queue=[] #queues act as a visited list for node , here adjancent node in
serted in the queueu
      if len(edge_list[i])!=0:    #if adjancent nodes of source node are prese
nt then make every adjacent nodes distance to 1 intially
        for x in edge_list[i]:
          temp[x]=1
          queue.append(x)

      while(len(queue)!=0):    #run this loop till we got the destination and
 till loop is not not empty.
        x=queue[0]                #take out node and assign to x
        queue.remove(queue[0])     #remove 1st node from the queue
        if x==j:                    #removed node is destination then stop the
algorihtm and run for next destination
          distance[i][j]=temp[x]    #assign the distance of src i to j from te
mp x .
          sum+=temp[x]
          break                       #then break
        else:
          for l in edge_list[x]:     #else take out all the adjancent neighbor
s and add into the queue
            if l not in temp.keys():
              temp[l]=temp[x]+1                     #along with intialse the
 distance of new node as per distance of remove node from source node+1
              queue.append(l)                # then append in queue
```

Averegae path length

In [74]:
```
print("Average path length is: sum of distances/nC2 :",((2*sum)/(len(n)*(len(n
)-1))))
```

```
Average path length is: sum of distances/nC2 : 5.092605138360519
```

diameter:

In [75]:
```
diameter=0 #initially diameter is equal to 0
for i in distance.keys():    #take the maximum distance as a diameter if the g
raph
  diameter=max(diameter,max(distance[i].values()))
```

In [76]:
```
print("diameter of the graph is :",diameter)
```

```
diameter of the graph is : 17
```

Average cluster coefficient:

cluster coefficient formula= Li /nC2

where Li is number of edges between the adjancent if node i and n is the total adjanct nodes of node i.

In [77]:
```
cluster_coefficient={}  #intitilialise the cluster coeffienct of nodes
for i in range(0,len(adjancency_matrix)):
  li=0
  for j in range(0,len(edge_list[i])):  #Loop for checking if there exist and
 edge between adjanct nodes of the source node i
    for k in range(j+1, len(edge_list[i])):
      if adjancency_matrix[edge_list[i][j]][edge_list[i][k]]==1 :  # if node e
xist the incerment Li
        li+=1
  if li!=0:
    cluster_coefficient[i]=(2*li)/(len(edge_list[i])*(len(edge_list[i])-1))
#here calculate cluster coeffcient by particular formula
```

In [78]:
```
temp_sum=0
for i in list(cluster_coefficient.values()):   #total sum for cluster coeffice
nt of each nodes
  temp_sum+=i
```

In [79]:
```
print("Average cluster coefficent: ",temp_sum/len(n))  #average cluster coeffi
cent is total sum of each cluster coefficent / total numbe rof nodes
```

```
Average cluster coefficent:  0.33078404030069036
```

In [80]:
```
cluster_coefficient #cluster coeffcient of each nodes.
```

Out[80]:
```
{0: 0.2,
 1: 1.0,
 2: 1.0,
 3: 0.2222222222222222,
 4: 0.16666666666666666,
 6: 0.5,
 7: 0.23809523809523808,
 8: 0.1,
 9: 0.3439153439153439,
 11: 0.9333333333333333,
 15: 0.5777777777777777,
 16: 0.8939393939393939,
 17: 0.4,
 21: 0.3333333333333333,
 22: 0.6666666666666666,
 23: 0.16483516483516483,
 24: 0.6666666666666666,
 28: 1.0,
 31: 0.12666666666666668,
 32: 0.2857142857142857,
 34: 0.3333333333333333,
 35: 0.2987012987012987,
 39: 0.2,
 40: 0.14285714285714285,
 41: 0.15384615384615385,
 43: 0.3181818181818182,
 45: 0.4666666666666667,
 46: 0.38095238095238093,
 48: 0.9,
 50: 0.14285714285714285,
 52: 1.0,
 54: 0.2,
 55: 0.8571428571428571,
 56: 0.2506938020351526,
 58: 0.34285714285714286,
 59: 1.0,
 60: 0.6666666666666666,
 62: 0.2909090909090909,
 63: 0.37777777777777777,
 65: 0.4642857142857143,
 67: 0.18181818181818182,
 68: 0.6444444444444445,
 69: 0.6666666666666666,
 70: 0.18038852913968548,
 72: 0.3333333333333333,
 73: 1.0,
 75: 1.0,
 78: 0.6944444444444444,
 79: 0.32142857142857145,
 81: 1.0,
 82: 0.13333333333333333,
 83: 0.6190476190476191,
 84: 0.6666666666666666,
 85: 0.5,
 86: 1.0,
 87: 0.34022988505747126,
 88: 0.2,
```

```
89: 0.1849390919158361,
90: 0.25019607843137254,
91: 1.0,
93: 0.3,
94: 1.0,
101: 0.5238095238095238,
102: 0.2857142857142857,
103: 0.6666666666666666,
104: 0.4,
106: 0.3333333333333333,
107: 0.5151515151515151,
108: 0.6,
109: 0.3333333333333333,
110: 1.0,
111: 0.5,
113: 0.4,
114: 0.17857142857142858,
115: 1.0,
116: 0.29004329004329005,
117: 0.7564102564102564,
118: 0.3333333333333333,
119: 0.8939393939393939,
120: 1.0,
121: 0.3,
123: 0.6,
124: 0.6666666666666666,
126: 0.5,
127: 0.8333333333333334,
128: 0.21666666666666667,
130: 0.3111111111111111,
131: 0.32,
134: 0.38095238095238093,
135: 0.07575757575757576,
136: 0.13186813186813187,
137: 0.6,
139: 1.0,
141: 0.1,
142: 0.42857142857142855,
143: 0.23076923076923078,
144: 0.8,
145: 0.5333333333333333,
146: 0.3055555555555556,
147: 0.4,
148: 0.3,
149: 0.7,
150: 0.7333333333333333,
151: 0.3523809523809524,
152: 0.6785714285714286,
154: 0.4696969696969697,
155: 0.5,
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158: 0.8055555555555556,
159: 0.3333333333333333,
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163: 0.4666666666666667,
164: 0.17316017316017315,
165: 1.0,
```

```
166: 0.4,
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170: 0.6666666666666666,
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175: 0.5,
176: 0.17857142857142858,
177: 0.3333333333333333,
178: 1.0,
179: 0.4090909090909091,
181: 0.22857142857142856,
182: 0.2021505376344086,
183: 0.19047619047619047,
184: 0.6,
185: 0.2222222222222222,
187: 0.26666666666666666,
189: 0.9,
191: 1.0,
193: 0.2777777777777778,
195: 0.2967032967032967,
198: 0.3054187192118227,
199: 0.6666666666666666,
202: 0.07142857142857142,
203: 1.0,
204: 1.0,
206: 0.6666666666666666,
208: 0.17777777777777778,
210: 0.8928571428571429,
212: 0.9333333333333333,
214: 0.42857142857142855,
215: 0.3333333333333333,
217: 0.24731182795698925,
220: 0.38095238095238093,
222: 0.6666666666666666,
223: 0.5714285714285714,
224: 0.17142857142857143,
225: 0.42857142857142855,
227: 0.0761904761904762,
229: 0.2731182795698925,
230: 0.3333333333333333,
232: 0.6,
235: 0.26666666666666666,
237: 0.9454545454545454,
238: 0.3333333333333333,
240: 0.2222222222222222,
241: 1.0,
242: 0.2777777777777778,
243: 0.3333333333333333,
244: 0.32142857142857145,
245: 0.24761904761904763,
246: 1.0,
248: 0.27666666666666667,
249: 0.9,
251: 0.5,
252: 0.8928571428571429,
253: 0.24166666666666667,
254: 0.47794117647058826,
```

```
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260: 0.3333333333333333,
261: 0.3,
262: 0.6666666666666666,
263: 1.0,
264: 0.3181818181818182,
265: 0.05331945408281286,
269: 0.2857142857142857,
270: 1.0,
274: 0.8939393939393939,
275: 0.5555555555555556,
276: 0.39285714285714285,
279: 1.0,
282: 0.2,
285: 0.6666666666666666,
288: 0.21021021021021022,
289: 0.28615384615384615,
290: 0.6,
291: 0.5,
292: 0.3055555555555556,
293: 0.16666666666666666,
297: 1.0,
298: 0.3333333333333333,
299: 0.12727272727272726,
300: 0.2857142857142857,
302: 0.3333333333333333,
305: 0.6666666666666666,
306: 1.0,
307: 0.6666666666666666,
311: 0.38461538461538464,
313: 0.6666666666666666,
315: 0.8333333333333334,
316: 1.0,
317: 0.3387096774193548,
318: 0.3333333333333333,
319: 0.42857142857142855,
320: 0.3333333333333333,
321: 0.2,
322: 1.0,
323: 0.4090909090909091,
324: 0.4166666666666667,
325: 0.7,
327: 0.5,
328: 0.4,
329: 0.4090909090909091,
331: 0.3333333333333333,
333: 0.3333333333333333,
334: 0.7692307692307693,
335: 0.5333333333333333,
338: 0.5238095238095238,
339: 0.6666666666666666,
340: 0.19932659932659932,
342: 0.4166666666666667,
343: 0.2134387351778656,
```

```
345: 0.2,
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347: 0.5238095238095238,
348: 1.0,
350: 0.31521739130434784,
351: 0.7454545454545455,
352: 0.16374269005847952,
353: 0.8333333333333334,
354: 0.5,
355: 0.4642857142857143,
356: 0.6666666666666666,
357: 0.2,
358: 0.8333333333333334,
360: 0.13333333333333333,
361: 0.3333333333333333,
362: 0.6666666666666666,
363: 0.3055555555555556,
364: 0.23809523809523808,
365: 0.6,
368: 0.21428571428571427,
369: 0.16666666666666666,
372: 0.39166666666666666,
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375: 0.3888888888888889,
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385: 0.5333333333333333,
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389: 0.11264367816091954,
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395: 0.8333333333333334,
397: 0.15151515151515152,
398: 0.3888888888888889,
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405: 1.0,
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413: 0.8333333333333334,
414: 0.3333333333333333,
416: 0.5,
417: 1.0,
419: 0.6363636363636364,
420: 1.0,
421: 0.3333333333333333,
424: 0.25,
426: 0.16666666666666666,
427: 0.8,
429: 0.5238095238095238,
430: 1.0,
432: 0.12380952380952381,
433: 0.3333333333333333,
434: 0.23376623376623376,
```

```
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437: 0.75,
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440: 0.3,
441: 0.4222222222222222,
444: 0.3333333333333333,
445: 0.4,
446: 0.3157894736842105,
448: 0.39285714285714285,
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457: 1.0,
458: 0.2,
459: 0.07142857142857142,
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461: 0.3333333333333333,
463: 0.3333333333333333,
465: 0.5083333333333333,
466: 1.0,
467: 0.5,
469: 0.6071428571428571,
470: 0.6666666666666666,
472: 1.0,
473: 0.38095238095238093,
474: 0.3333333333333333,
476: 0.16666666666666666,
478: 0.4,
479: 0.42857142857142855,
480: 0.6666666666666666,
484: 0.6666666666666666,
485: 0.4666666666666667,
486: 1.0,
487: 1.0,
488: 0.3333333333333333,
491: 0.18095238095238095,
494: 0.3181818181818182,
495: 0.3333333333333333,
497: 0.6666666666666666,
498: 0.11931818181818182,
501: 0.4444444444444444,
502: 0.5238095238095238,
504: 1.0,
505: 0.2605042016806723,
507: 0.26666666666666666,
508: 0.42857142857142855,
510: 0.4,
515: 0.6666666666666666,
516: 0.7692307692307693,
517: 0.6,
518: 0.07130333138515488,
```

```
522: 0.43636363636363634,
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525: 1.0,
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527: 0.6190476190476191,
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533: 1.0,
535: 0.6,
536: 0.15555555555555556,
538: 0.26666666666666666,
539: 0.3333333333333333,
540: 0.6666666666666666,
543: 0.7333333333333333,
545: 0.2597402597402597,
546: 0.5714285714285714,
547: 0.5555555555555556,
549: 1.0,
550: 0.2714285714285714,
552: 0.8333333333333334,
554: 0.2,
555: 0.17647058823529413,
557: 0.3,
558: 0.3333333333333333,
559: 0.5,
563: 0.2564102564102564,
566: 0.3333333333333333,
567: 0.6666666666666666,
570: 0.5494505494505495,
571: 1.0,
572: 0.6,
574: 1.0,
576: 0.2426470588235294,
577: 0.2222222222222222,
578: 0.2,
579: 0.3333333333333333,
580: 0.42857142857142855,
581: 0.14285714285714285,
583: 0.6666666666666666,
584: 0.3047619047619048,
585: 0.16666666666666666,
587: 1.0,
588: 1.0,
589: 1.0,
591: 0.5,
593: 0.27472527472527475,
594: 1.0,
595: 0.6,
596: 0.5357142857142857,
597: 0.35177865612648224,
598: 0.8,
599: 0.42857142857142855,
601: 0.41125541125541126,
602: 1.0,
603: 0.25071225071225073,
608: 0.2857142857142857,
609: 0.6666666666666666,
```

```
610: 1.0,
611: 0.15356151711378355,
612: 0.5,
613: 0.5583333333333333,
615: 1.0,
616: 0.2727272727272727,
617: 0.6666666666666666,
619: 0.3}
```

In [80]: