Network Science
PHYS 5116, Fall 2018

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Assignment 1, due by October 5th, no later than 6 pm.

Late assignments may be accepted, but with a penalty of 1 percentage point per hour late (rounded up).

Write your name at the top of your assignment before handing it in. Staple all pages together. If you hand in a digital/scanned copy, please turn in a ***single*** *PDF or Word file containing all text and images.*

1. **Matrix formalism**
   Problem 2.12.2 in the book.

2. **Erdős-Rényi graph**
   Problem 3.11.1 in the book. But use $N = 7500$ and $p = 10^{-4}$.

3. **Graph representation**
   Problem 2.12.3 in the book.

4. **Snobbish social networks**
   Consider a random network model where links are not drawn in an unbiased way, but rather with a tendency to connect nodes that share a common trait. As a simplistic model we assume that there are N red nodes and N blue nodes. The probability for an edge between nodes sharing the same color is p, while the probability for an edge between nodes of different colors is q. The network is "snobbish" if $p > q$. Indeed, for $q = 0$ the result is a network of two disjoint subnetworks each consisting of one color of node.

   a) In a very snobbish network (where $p \gg q$), what are the minimal values of p and q (each in terms of N) required to ensure global connectivity. *Hint:* First consider the "maximally-snobbish" case mentioned above, in which $q = 0$; what is required of p for each subnetwork to be connected? Then consider what, in addition, would need to change to make the overall network connected...

   b) For large networks satisfying the criteria derived in (a), what is the expected shortest path length between two nodes of the same color? Two nodes of different colors? Based on these answers, do these networks exhibit the small world property? Why or why not?

5. **Bipartite networks**
   Problem 2.12.5 in the textbook, plus part (d) of Problem 2.12.6.