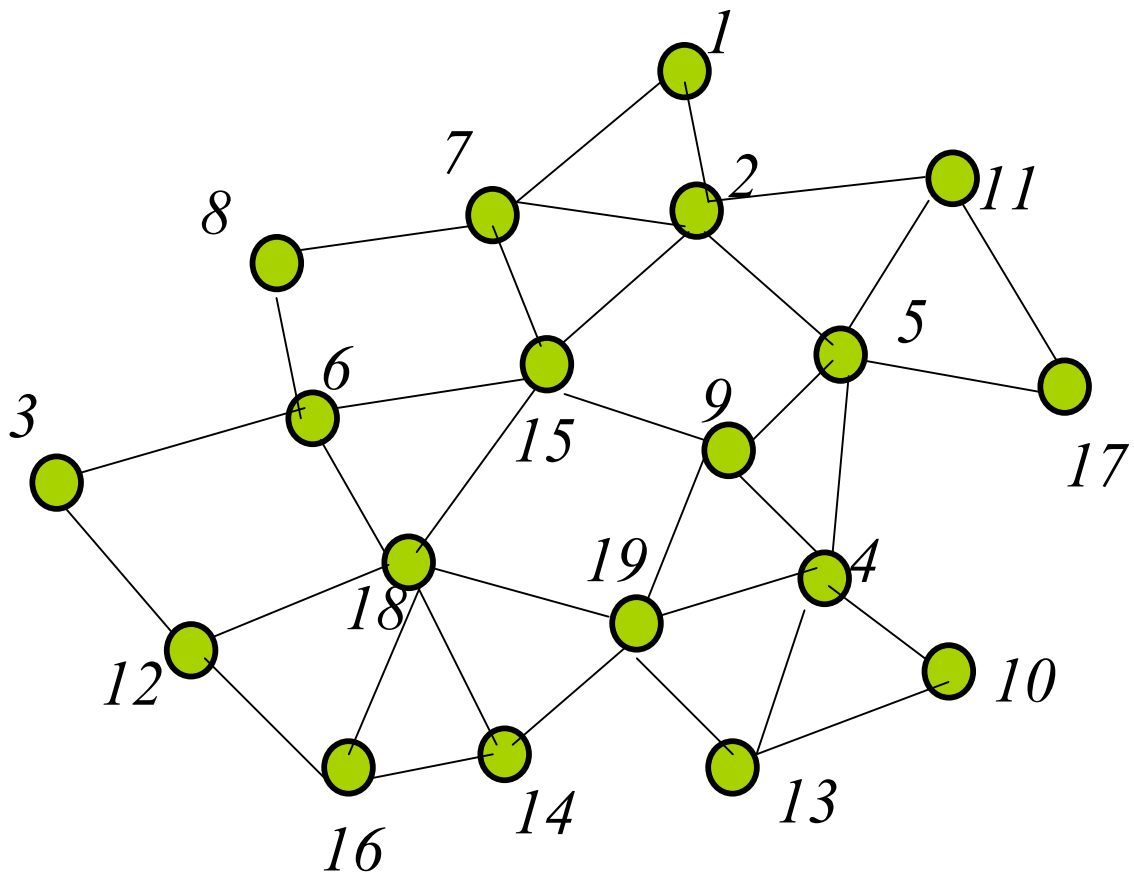
Wireless Ad Hoc Networking: Quiz 1, February 4, 2010

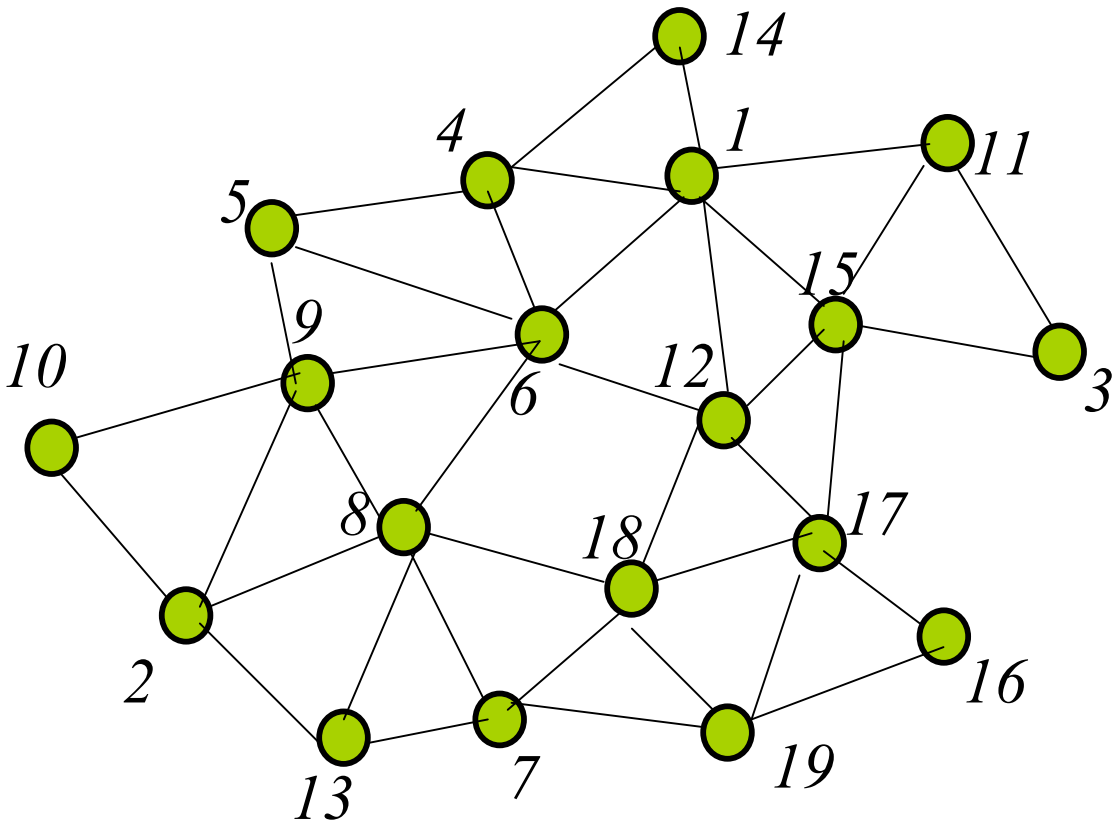
Closed book exam, 100 minutes

Name: _____ Student number: _____

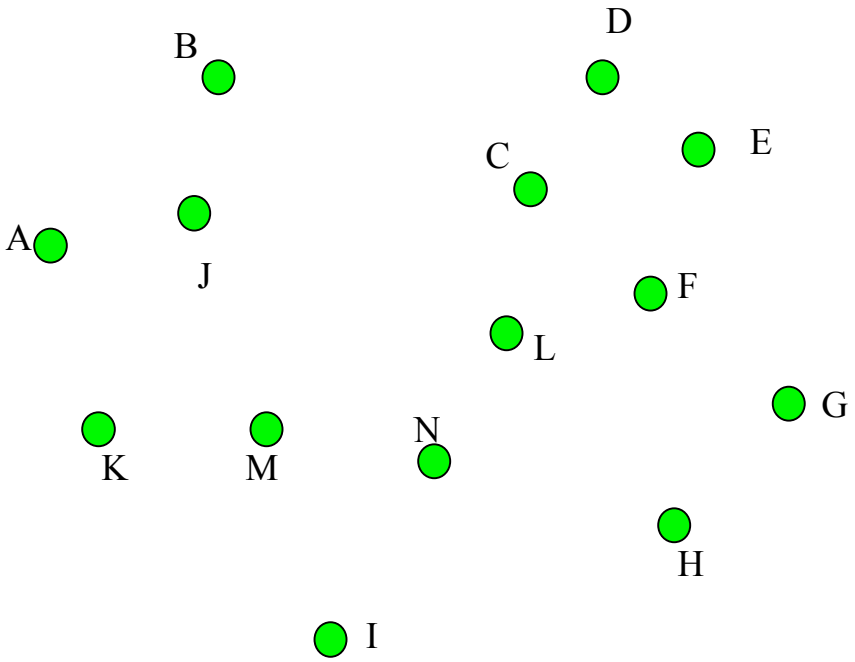
1. (16 marks) The clustering algorithm covered in class works as follows. Each node has a unique key and is aware of keys of its neighboring nodes. Clusterheads are selected in rounds. Initially all nodes are undecided. In each round, nodes that have **higher IDs than any of their undecided neighbors** declare themselves to be clusterheads and inform neighbors about such decisions. These neighbors then decide not to become clusterheads and also inform neighbors about this decision. Apply the clustering algorithm to the example network. Use key= ID in deciding roles so that higher ID nodes have priority in becoming clusterheads. To answer, simply list clusterheads created in each round.



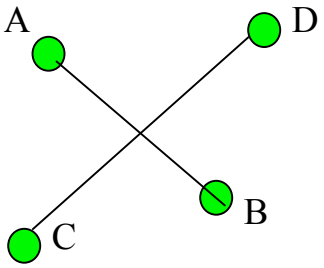
2. (16 marks) Apply the generalized covering rule to determine which nodes do not belong to the connected dominating set. For each such node, list the neighbors that cover it. Node A is covered by neighboring nodes B, C, … if B, C, … are connected (that is, create connected subgraph), any neighbor of A is neighbor of (at least) one of B, C,.. and key(A) < min (key(B), key(C),…). Use key=ID, ordered numericaly (1<2<3<…). Node A is also considered covered is it does not have two unconnected neighbors.

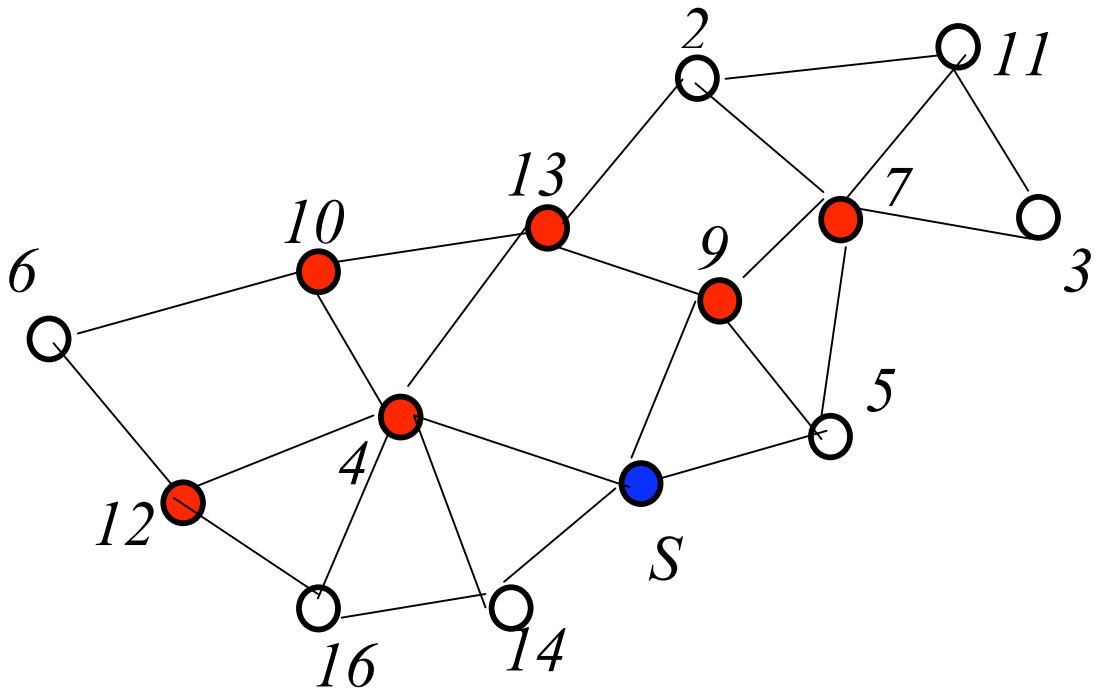


3. (8+8+8 marks) a) An edge UV belongs to Gabriel Graph (GG) of a set S if no other point from S is located inside the circle with diameter UV. Draw Gabriel graph (GG) for the network below. Simply draw/list edges that you believe are in the GG.



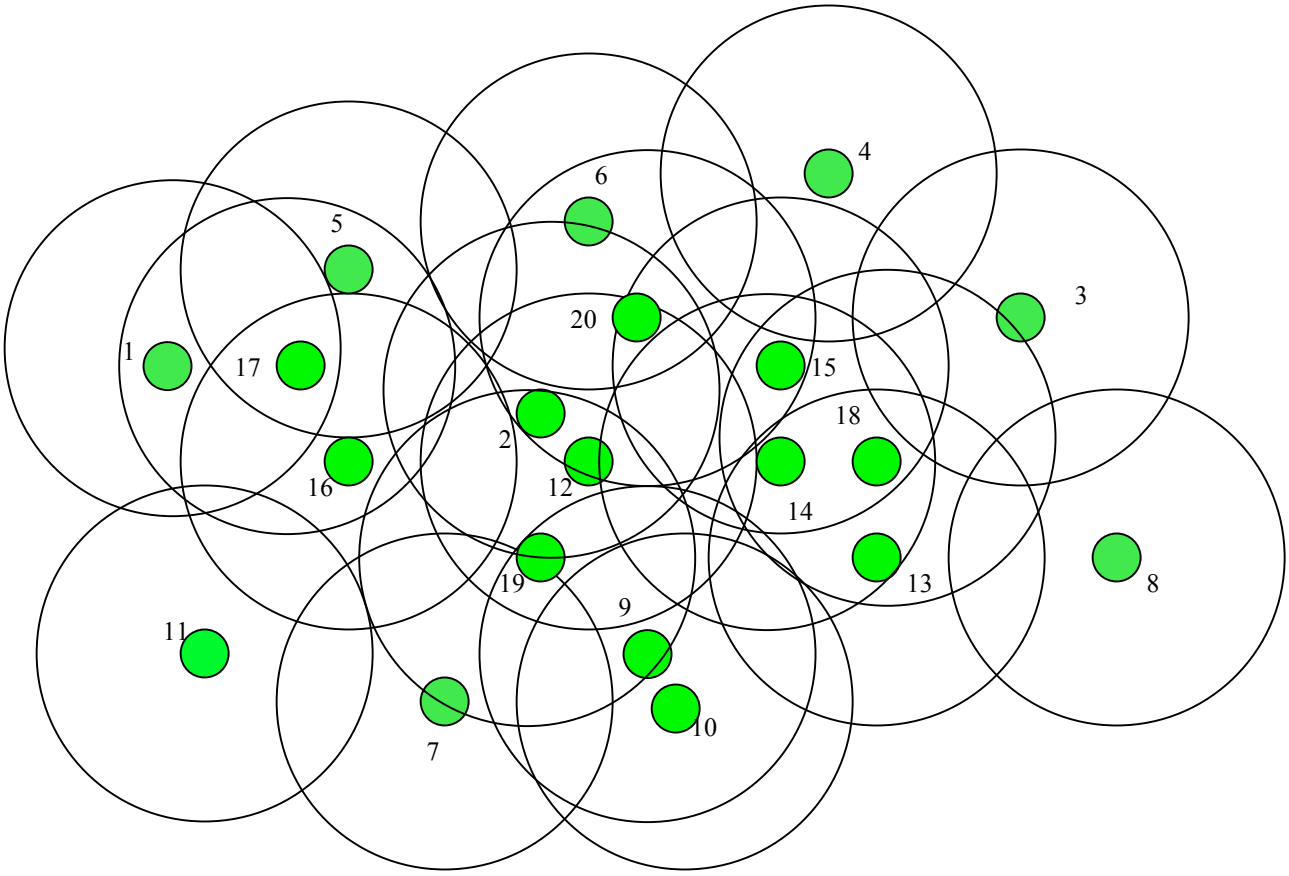
b) Use only edges from GG in your routing. Show two recovery paths (by right-hand and left-hand rules) when recovery starts from node B and message is destined for node D.
c) Prove that GG is planar graph. More precisely, prove that two edges AB and CD of GG cannot intersect in their interiors (like in figure bellow).





4. (16 marks) Follow **neighbor elimination and dominating set** based broadcasting on above figure, with S as the source node, and nodes 12, 4, 10, 13, 9 and 7 being in the dominating set. The key for timeout comparisons is *(timeout, ID);* that is, if timeouts are same, node with lower ID number will transmit first. For timeout, use formula *timeout=1/(number of uncovered neighbors)*. List nodes that will retransmit in the process, in the order of retransmissions. After each transmission, list which nodes have timeouts and how long are they.

5. (12 marks) Assume that all sensors have the same transmission range R, and same sensing range S. Consider the perimeter coverage criterion, which is as follows. Sensing range of a circle is claimed to be covered by sensing ranges of its neighboring (within communication range) circles if and only if its (sensing) perimeter is covered by sensing ranges of neighbors. Does it always work correctly? That is, does perimeter coverage imply coverage of whole circle? How this depends on R/S ratio? Either give a (concise) proof, or show counterexample, for each claim made.



6. (16 marks) Localized sensor area coverage algorithm works as follows. Each sensor selects a random timeout. Suppose that timeouts expire in the order as indicated by numbers: 1,2,3,…,20. Assume also that communication range is much larger than sensing range (so all decision are received by sensing neighbors). Each transmission contains the position of sensor. At the end of its timeout, if sensing are is not fully covered, sensor decides to be active, and informs neighbors. Otherwise it decides to be passive, but still sends a message to neighbors informing about the decision. This is PN variant. What sensors will at the end be active? Suppose also that at the end there is another round of timeout (use same order) for sensors which decided to be active. Each such sensor will decide to be passive if other active sensors cover its area (some of these active sensors decided their status after given sensor). This is a retreat option (PNR variant). Retreat decisions are communicated to neighbors. Which sensors will retreat in this example?