1. Consider a GSM system in which there are 4 full duplex carriers making up a logical cell. On two of the carriers, 1 channel is dedicated for CCCH, i.e., one uplink RACH and one set of downlink channels. Assume each time slot can carry one signaling message. If there are 80,000 users/cell, and each user registers 1/20 minutes, receives 1.8 calls/hour, and makes 1.8 calls/hour, determine the utilization of the PAGCH and RACH. Assume the standard GSM assignment of time-slots to the PAGCH (4 in the first cycle, 8 in the additional cycles). (30 pts)

2. Consider the following GSM system made up of 150 MSC/VLRs. Each user receives 3 calls/hour, there are 300 user/sq. mile, users move randomly at 10 miles/hr. HLRs in this system can support 28,000 users, and MSC cover a perimeter of 30 miles. If HLRs can process 100 incoming operations/seconds maximum, and VLR/MSCs can process 50 incoming operations/second, determine the delay locate a user during incoming calls. Ignore paging delay. Operations only include messages requesting an action, not responses. In this example, assume that authentication information is always available from the old VLR. (50 pts)

3. Repeat problem 2, except in this example, assume that authentication information is available from the old VLR 80% of the time. What change in the network equipment would most improve performance? (20 pts)