PROBLEM STATEMENT
Your mobile phone company is given a contract to build a GSM network to cover the urban and suburban areas. The urban area to be covered is 4,000 km$^2$ and the suburban area to be covered is 7,000 km$^2$.

GSM system data
- RF channel bandwidth: 200 kHz
- Number of speech channels per RF carrier: 8
- Base station antenna gain: 22 dBi
- Mobile antenna gain: 0 dBi
- Receive cable connector loss: 3 dB
- Noise figure (Mobile station): 8 dB
- Noise figure (Base Station): 6 dB
- GoS: 2%
- Required S/I: 16 dB
- Frequency reuse factor: 4
- Rollout time for the network: 5 years
- Projected population growth rate: 7% per year
- Maximum transmit power of the mobile: 20 mW
- Maximum transmit power of the base station: 400 mW
- Thermal noise density: -174 dBm/Hz
- Present urban population: 450,000
- Present suburban population: 650,000
- Market penetration in urban area: 30%
- Market penetration in suburban area: 25%
- Average call holding time in urban area: 120 seconds
- Average call holding time in suburban area: 130 seconds
- Available bandwidth in urban and suburban area: 10 MHz
- One-km intercept path loss in dB/km in urban area: -100 dB/km
- Slope of path-loss curve in urban area (g): 4.0
- One-km intercept path loss in dB/km in suburban area: -96 dB/km
- Slope of path-loss curve in suburban area (g): 3.8
- Building penetration loss in urban area: 17 dB
- Building penetration loss in suburban area: 14 dB
- Average traffic per subscriber: 0.012 Erlangs
- Assume 1.0 handover per call/subscriber in the urban area and 0.6 handover per call/subscriber in the suburban area
**Equipment Limit**

- MSC: capacity 100,000 BHCA; maximum connections: 6 BSCs
- BSC: capacity 800 Erlangs; maximum connections: 60 BTSs
- HLR: maximum capacity: 400,000 customers
- VLR: maximum capacity: 300,000 customers

Note: VLR can not be shared by MSCs.

Assume any other data that is required.

Your design should provide the required equipment (i.e., MSC, BSC, BTS, HLR, VLR) and cell radius in the two areas.