Question 1.

For interference of -100 dBm, distance between co-channel cells $D$ must be given by:

$$10 \log_{10} \left( \frac{D}{1 \text{ metre}} \right)^{-3.52} = -100 \text{ dBm}$$

$$-3.52 \log_{10} D = -10$$

$$\log_{10} D = 2.841$$

$$D = 693 \text{ m}$$

(Alternatively, the calculations can be done on a linear scale:

$$-100 \text{ dBm} = 10^{-13} \text{ W}$$

$$\left( \frac{D}{1 \text{ metre}} \right)^{-3.52} = 10^{-13} \text{ which gives } D = (10^{-10})^{0.52} = 693 \text{ m}$$)

For 7-cell reuse:

$$\frac{1}{3} \left( \frac{D}{r} \right)^2 = 7 \Rightarrow r = \frac{D}{\sqrt{21}} = 151 \text{ m}$$

For 4-cell reuse:

$$\frac{1}{3} \left( \frac{D}{r} \right)^2 = 4 \Rightarrow r = \frac{D}{\sqrt{12}} = 200 \text{ m}$$

Question 2.

For omnidirectional cells:

$$C = \frac{1}{2(q-1)^{-\gamma} + 2q^{-\gamma} + 2(q+1)^{-\gamma}} \quad \text{equation (1)}$$

Require $C/I \geq 17 \text{ dB} = 10^{17/10} = 50.1$ (linear)

We can take two approaches:

1) Solve eqn (1) for $q$ (need to do this iteratively)

2) Note that $q$ can take on only a few possible discrete values, and calculate $C/I$ for those values

We’ll try the second approach:

- $K = 7 \Rightarrow q = 4.58 \Rightarrow C/I = 14.4 \text{ dB}$
- $K = 9 \Rightarrow q = 5.20 \Rightarrow C/I = 16.5 \text{ dB}$
- $K = 12 \Rightarrow q = 6.0 \Rightarrow C/I = 19.0 \text{ dB}$

Therefore choose $K = 12$
For 120 degree sectors, follow the same procedure:

\[
\frac{C}{I} = \frac{1}{(q + 0.7)^{-\gamma} + q^{-\gamma}}
\]

K = 4 => q = 3.46 => C/I = 17.2 dB
K = 7 => q = 4.58 => C/I = 21.2 dB

Therefore, for omnidirectional sectors, must use at least 12 cell clusters.
For 120 degree sectorised cells, must use at least 4 cell clusters.

**Question 3**

(a) \( \gamma = 4 \)

First consider a 7-cell reuse pattern.
The normalized co-channel reuse distance is \( D/R = \sqrt{3 \times 7} = 4.583 \).
The carrier to interference ratio is

\[
(C/I) = \frac{1}{6} \times (4.583)^{4} = 75.3 = 18.66 \text{ dB}
\]

Since this is greater than the minimum required C/I, a 7-cell cluster can be used.

(a) \( \gamma = 3 \)

First consider a 7-cell reuse pattern.
The normalized co-channel reuse distance is \( D/R = 4.583 \).
The carrier to interference ratio is

\[
(C/I) = \frac{1}{6} \times (4.583)^{3} = 16.04 = 12.05 \text{ dB}
\]

Since this is less than the minimum required C/I, we need to use a larger cluster size.

The next larger cluster size is 9 \((i = 3 \text{ and } j = 0)\).
The normalized co-channel reuse distance is \( D/R = \sqrt{3 \times 9} = 5.196 \).
The carrier to interference ratio is

\[
(C/I) = \frac{1}{6} \times (5.196)^{3} = 23.38 = 13.69 \text{ dB}
\]

This is still less than the minimum required C/I, and we need to use a larger cluster size.

The next larger cluster size is 12 \((i = j = 2)\).
The normalized co-channel reuse distance is \( D/R = \sqrt{3 \times 12} = 6 \).
The carrier to interference ratio is

\[
(C/I) = \frac{1}{6} \times (6)^{3} = 36 = 15.56 \text{ dB}
\]

Since this is greater than the minimum required C/I, a 12-cell cluster can be used.