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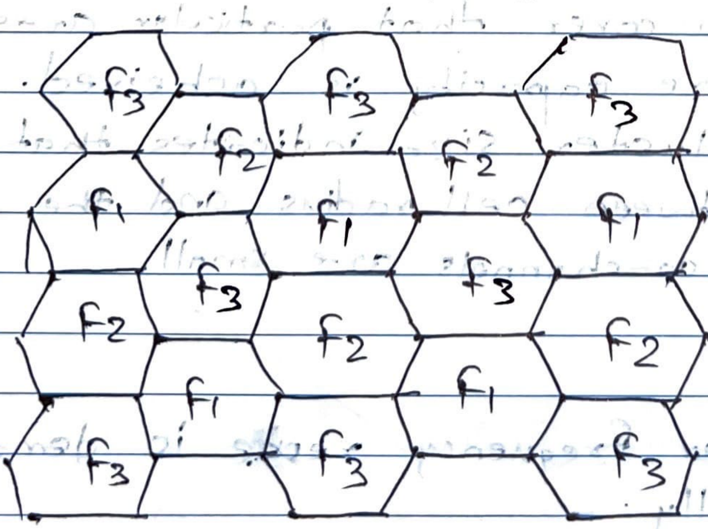
Experiment No. 8

Aim: Write a program to demonstrate Cellular frequency reuse.

Theory:

- Frequency reuse is the technique of using the same radio frequencies on radio transmitter sites within a geographic area that are separated by sufficient distance to cause minimal interference with each other.
- To avoid interference in cellular system, each cell uses a different set of frequencies are compared to its immediate neighbors.
- In other words, no two neighbors use the same set of frequencies as there will be interference.
- A set of several cells are further grouped into clusters. Cells within the same clusters do not use the same frequency sets.



(3 cells cluster)

- Consider a cellular system which has S full duplex channels available for use.
- Assume that the S channels are divided into N number of cells and each cell is allocated a group of K channels. ($K<S$)
- Thus, total number of channels per cell is $K = S/N$
- Therefore, $S = KN$
- The N cells which collectively use the complete set of available frequencies is called cluster.
- The factor N is called the cluster size.
- The frequency reuse factor of cellular system is given by reciprocal of cluster size i.e. $\frac{1}{N}$
- If the cluster size N is reduced while the cell size remains constant, more clusters are required to cover that particular area and hence more capacity is acheived.
- A large cluster size indicates that the ratio between cell radius and the distance between co-channels are small.

- Conclusion:

The cellular frequency reuse is demonstrated successfully.

Pravin (A+)

Code:

```
import matplotlib.pyplot as plt
import numpy as np


def hexagonal_grid(radius, num_cells):
  centers = []
  for i in range(-num_cells, num_cells + 1):
    for j in range(-num_cells, num_cells + 1):
      if abs(i + j) <= num_cells:
        x = 1.5 * radius * i
        y = np.sqrt(3) / 2 * radius * (2 * j + i)
        centers.append((x, y))
  return centers


def plot_cells(centers, radius, selected_i, selected_j):
  fig, ax = plt.subplots()
  ax.set_aspect('equal')

  for center in centers:
    hexagon = plt.Polygon(np.array([[
        np.cos(np.pi / 3 * i) * radius + center[0],
        np.sin(np.pi / 3 * i) * radius + center[1]
    ] for i in range(6)]),
                          edgecolor='black',
                          linewidth=2,
                          fill=None)
    ax.add_patch(hexagon)

  plt.scatter(*zip(*centers), color='red', marker='o', label='Cell
Centers')

  selected_center = (1.5 * radius * selected_i,
                     np.sqrt(3) / 2 * radius * (2 * selected_j +
selected_i))
  plt.scatter(*selected_center,
              color='blue',
              marker='x',
              label='Selected Cell Center')

  plt.title(
```

```
      f'Cellular Frequency Reuse - Hexagonal Grid\nSelected Cell:
i={selected_i}, j={selected_j}'
  )
  plt.xlabel('X-coordinate')
  plt.ylabel('Y-coordinate')
  plt.legend()
  plt.show()


def main():
  radius = 1.0
  num_cells = 3

  selected_i = int(input('Enter i value: '))
  selected_j = int(input('Enter j value: '))

  cell_centers = hexagonal_grid(radius, num_cells)
  plot_cells(cell_centers, radius, selected_i, selected_j)


if __name__ == "__main__":
  main()
```

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Output: