HW1_Prob_6

February 10, 2025

1 Problem 6

Necessary packages

```
[23]: import numpy as np
      import matplotlib.pyplot as plt
```

Make the formula for self mutual inductance:

```
[19]: def selfInduct(r: float, l: float) -> float:
          # Constant for mu
          mu = (4 * np.pi) * (10 ** -7)

          # The actual formula
          lSelf = 0.0

          if (l > r):
              # Convert from mm to cm
              r * 1e-1
              l * 1e-1

              lSelf = (.002 * l) * (np.log((2 * l) / r) - (3 / 4)) # returns uH/cm
              lSelf *= 100 # puts in back in nH/mm
          else:
              print("warning")

          return lSelf

      def mutualInduct(s: float, l: float) -> float:
          # Constant for mu
          mu = (4 * np.pi) * (10 ** -7)

          mSelf = 0.0

          # Convert from mm to cm
          s * 1e-1
          l * 1e-1
```

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```python
    mSelf = (.002 * l) * (np.log((2 * l) / s) - 1) # returns uH/cm
    mSelf *= 100 # puts in back in nH/mm


    return mSelf

def totalInduct(s: float, l: float, r: float):
    totalWMut = 0.0
    totalWOMut = 0.0

    totalWMut = (2 * (selfInduct(r, l))) - (2 * mutualInduct(s, l))
    totalWOMut = (2 * (selfInduct(r, l)))

    return totalWMut, totalWOMut
```

Create an array of spacings

```python
[20]: # Arranging an array from 1mm to 10mm (.001m to .01m)
      spacing = np.linspace(1, 10, 15) # This is in mm

      print(spacing)
```

```
[ 1.          1.64285714  2.28571429  2.92857143  3.57142857  4.21428571
  4.85714286  5.5         6.14285714  6.78571429  7.42857143  8.07142857
  8.71428571  9.35714286 10.        ]
```

Calculate the inductances

```python
[21]: totalWMuts = []
      totalWOMuts = []

      len = 10 # this in in mm
      # diam is 5 mils (0.127 mm), so rad is 0.0635 mm
      rad = 0.0635

      for s in spacing:
          x1, x2 = totalInduct(s, len, rad)
          totalWMuts.append(x1)
          totalWOMuts.append(x2)
```
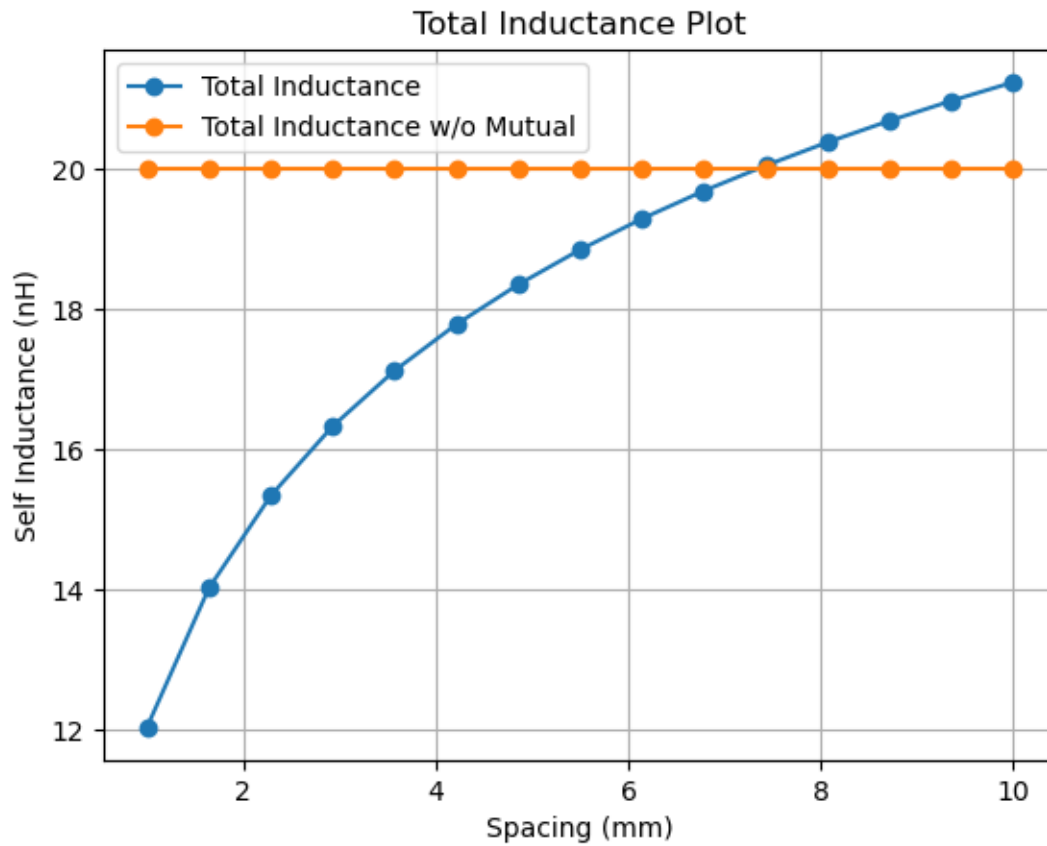
Plot

```python
[22]: fig, ax = plt.subplots()

      ax.plot(spacing, totalWMuts, marker='o', linestyle='-', label='Total␣
       ↪Inductance')
      ax.plot(spacing, totalWOMuts, marker='o', linestyle='-', label='Total␣
       ↪Inductance w/o Mutual')
```

```
ax.set(xlabel='Spacing (mm)', ylabel='Self Inductance (nH)',
       title="Total Inductance Plot")
ax.grid()
ax.legend()
```

[22]: <matplotlib.legend.Legend at 0x2ec8fb97250>

Since the inductance remains constant no matter the spacing, the line without mutal inductance barely changes which shows the amount of influence it has on the total inductance.