ER51 EXAMEN FINAL

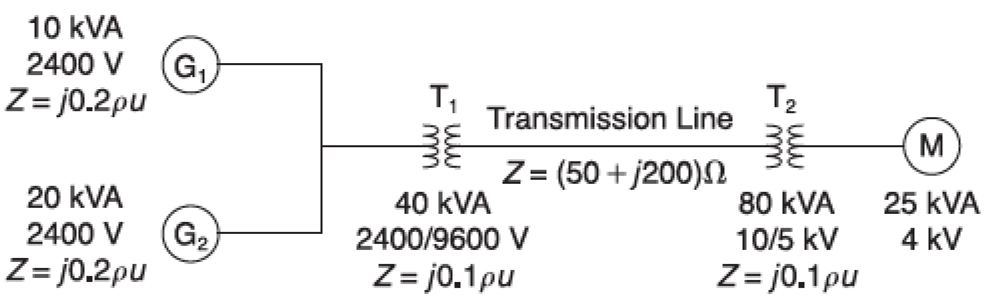
25 Juin 2024 de 8h00 à 10h00 en salle P243 à Sevenans

The use of lecture notes is not allowed.
You can reply either in English or in French.

QUESTION 1 (4 MARKS)

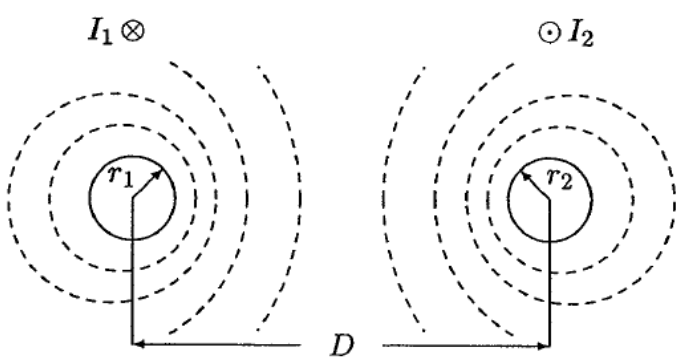
For the 3-phase system shown in figure below, draw an impedance diagram in per unit, by choosing 100kVA to be the base kVA and 2.4 kV as the base voltage for the generators.

Hint: you do not have to write the impedance of the motor, but only its rated power and rated voltage in pu.



QUESTION 2 (4 MARKS)

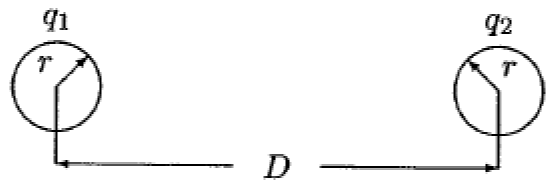
Using the concept of apparent inductance, calculate the inductance of a single-phase, two-wire line composed of two conductors, each carrying current in opposite directions as shown in the figure. Each conductor has a radius r_1 and r_2 respectively, and their centers are placed at a distance D apart. Of course, in module $I_1=I_2$.



Hint: do not forget that the currents flow in opposite directions and that the two conductors are therefore connected in series.

QUESTION 3 (4 MARKS)

Using the concept of logarithmic potential, calculate the capacitance of a single-phase, two-wire line composed of two conductors, one carrying a positive charge $+Q$ and the other carrying a negative charge $-Q$, as shown in the figure. Each conductor has a radius $r_1 = r_2 = r$, respectively, and their centers are placed at a distance D apart.

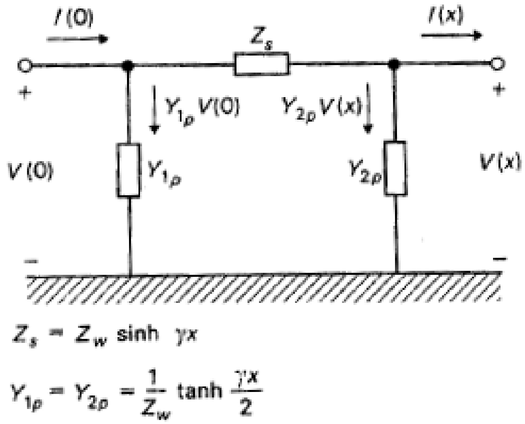


QUESTION 4 (8 MARKS)

A three-phase, 300 Km, 345kV line has series impedance of $Zs = 0.03 + j0.4\Omega/\text{km}$ and shunt admittance $Yp = j5.0 \times 10^{-6}$ S/km.

1. Calculate the line's characteristic impedance Z_w and the propagation constant γ. **(3 marks)**
2. Initially assume that the receiving end of the line is open-circuited and has a line-to-line voltage of 345kV. Calculate the sending end line-to-line voltage magnitude. **(3 marks)**
3. Draw the long line π equivalent circuit for this line, showing the values of all parameters. **(2 marks)**

Formulas Sheet



Long Line equivalent circuit

$$\begin{bmatrix} V(0) \\ I(0) \end{bmatrix} = \begin{bmatrix} \cosh \gamma x & Z_w \sinh \gamma x \\ \frac{1}{Z_w} \sinh \gamma x & \cosh \gamma x \end{bmatrix} \begin{bmatrix} V(x) \\ I(x) \end{bmatrix}$$

Logarithmic Potential

$$v_P = \sum_{v=1}^{n} \frac{Q_v}{2\pi\varepsilon_0} \ln \frac{1}{r_v} \ \text{V}$$

$$\sum_{v=1}^{n} Q_v = 0$$

Apparent Inductance

$$L_k = \frac{\mu_0}{2\pi}\left(\frac{\mu_k}{4} + \ln \frac{1}{R_k}\right) \ \text{H/m}$$

$$M_{kl} = \frac{\mu_0}{2\pi} \ln \frac{1}{D_{kl}} \text{H/m}$$