Assignment # 1

Q1. $i = (0.5\lambda x)^2 + \lambda^2 e^{2x}$ $\quad i = 3A, \quad x = 5cm$

Energy approach

$dW_f = i\, d\lambda \qquad$ with $dx = 0$

$$W_f = \int i\, d\lambda$$

$$= \int (0.25x^2 + e^{2x})\lambda^2 d\lambda$$

$$= \frac{0.25x^2 + e^{2x}}{3}\lambda^3$$

$$f_m = -\frac{\partial}{\partial x} W_f' \Big|_{\lambda = \text{Constant}}$$

$$= -\frac{\lambda^3}{3}\frac{\partial}{\partial x}(0.25x^2 + e^{2x})$$

$$= -\frac{\lambda^3}{3}(0.5x + 2e^{2x})$$

But, $\lambda = \dfrac{i^{\frac{1}{2}}}{(0.25x^2 + e^{2x})^{\frac{1}{2}}}$

for $i = 3A, \quad x = 5cm \quad \lambda = 1.647\ Wb$

Therefore, $f_m = -\dfrac{(1.647)^3}{3}(0.5 \times 0.05 + 2e^{2\times 0.05})$

$$= -3.329\ N$$

Coenergy approach

$$\lambda = \frac{i^{\frac{1}{2}}}{(0.25x^2 + e^{2x})^{\frac{1}{2}}} = (0.25x^2 + e^{2x})^{-\frac{1}{2}}\, i^{\frac{1}{2}}$$

$W_f' = \int \lambda\, di \qquad$ with $dx = 0$

$$= \int (0.25x^2 + e^{2x})^{-\frac{1}{2}}\, i^{3/2}\, di$$

$$= \frac{2}{3}(0.25x^2 + e^{2x})^{-\frac{1}{2}}\, i^{3/2}$$

$$f_m = +\frac{\partial}{\partial x} W_f' \Big|_{i = \text{Constant}}$$

$$= \frac{2}{3} i^{3/2} \frac{\partial}{\partial x}(0.25x^2 + e^{2x})^{-\frac{1}{2}}$$

$$= \frac{2}{3}\left(-\frac{1}{2}\right) i^{3/2}(0.25x^2 + e^{2x})^{-3/2}(0.5x + 2e^{2x})$$

for $i = 3A \quad x = 5cm$

$$f_m = -\frac{1}{3} 3^{3/2}(0.25(0.05)^2 + e^{2\times 0.05})^{-3/2}(0.5 \times 0.05 + 2e^{2\times 0.05})$$

$$= -3.329\ N$$