The Ohio State University
Department of Electrical and Computer Engineering

ECE 743
Spring 2010

Quiz #2

April 15, 2010

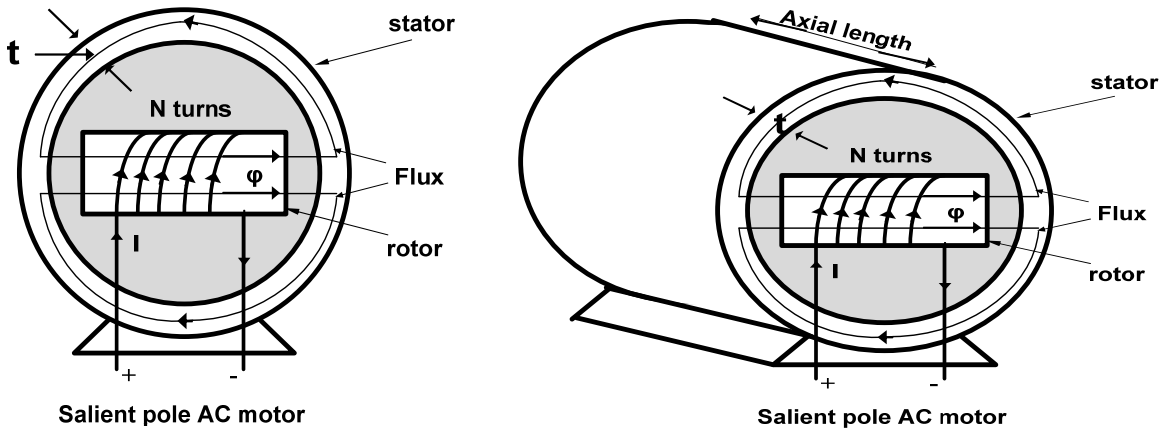
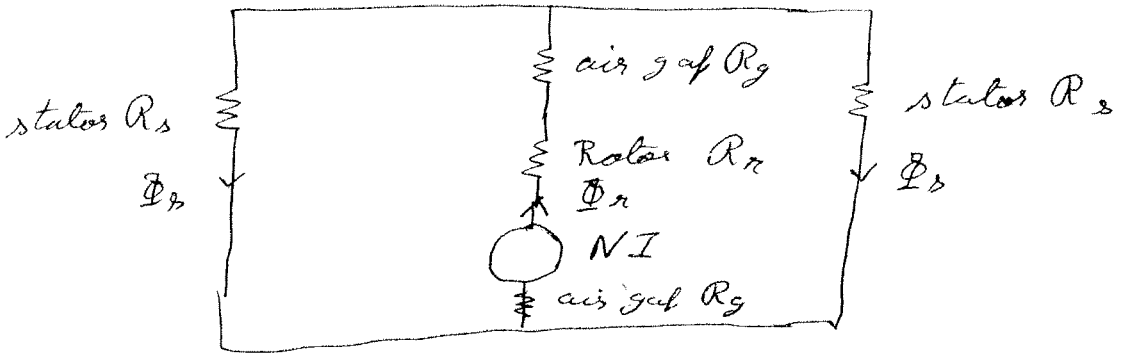


Figure Two different views of the same motor

1. Consider the electric motor shown in the figure. Assume the mean length of stator is 0.4 meter for each flux path and air gap length is .002 meter. The thickness, t, of the stator is 1cm and its axial length is 10 cm. The length of the rotor flux path is 0.2 meter and its cross-sectional area is 20 cm^2. Permeability of air is: $\mu_0 = 4\pi \times 10^{-7}$ H/m, relative permeability of the core material is 100. Do the following:
   i) Give the magnetic circuit
   ii) Find the reluctance
   iii) The flux density in the stator in tesla if the number of turns N is 10 and current is 1 A.

i) Magnetic Circuit



ii) $\mathcal{R}_r = \dfrac{l_r}{\mu_0 \mu_{r,core} A_r} = \dfrac{0.2}{4\pi \times 10^{-7} \times 100 \times 20 \times 10^{-4}}$

$= 795.77 \times 10^3$ A/Wb

$2 \times \mathcal{R}_g = \dfrac{l_g}{\mu_0 A_g} = \dfrac{0.002}{4\pi \times 10^{-7} \times 20 \times 10^{-4}}$, total gap = 0.002 m for 2 gaps put together

$= 795.77 \times 10^3$ A/Wb

$\mathcal{R}_s = \dfrac{l_s}{\mu_0 \mu_{rcore} A_s}$, $l_s = 0.4$, $A_s = t \times$ axial length $= 1 \times 10 = 10\ cm^2$

$= \dfrac{0.4}{4\pi \times 10^{-7} \times 100 \times 10 \times 10^{-4}} = 3183.1 \times 10^3$ A/Wb

Equivalent permeance $= \mathcal{R} = \mathcal{R}_r + 2\mathcal{R}_g + \mathcal{R}_s/2$

$= (795.77 + 795.77 + 3183.1/2) \times 10^3$

$= 3183.1 \times 10^3$

iii) Flux in rotor $= \Phi_r = NI/\mathcal{R} = 10 \times 1 / 3183 \times 10^3$

$= 3.142\ \mu$Wb.

Flux in stator $= \Phi_s = \Phi_r/2 = 1.57\ \mu$Wb.

∴ The flux density in stator $= B_s = \dfrac{\Phi_s}{A_s} = \dfrac{1.57 \times 10^{-6}}{10 \times 10^{-4}}$

$= 1.57$ mT