

Homework 1 – Introduction to AC Machines

This homework is to be solved using computational tools (such as MATLAB). You should show your work (how the resultant plot is obtained analytically, and required explanations).

*The provided template must be used and the homework should be submitted by converting the .m file solution to pdf by using **publish** command. Required explanations and several tips are given in the template.*

Q.1. Consider the stator side (double layer) of a 50 Hz AC machine shown in Fig. 1. Each coil side has 8 turns.

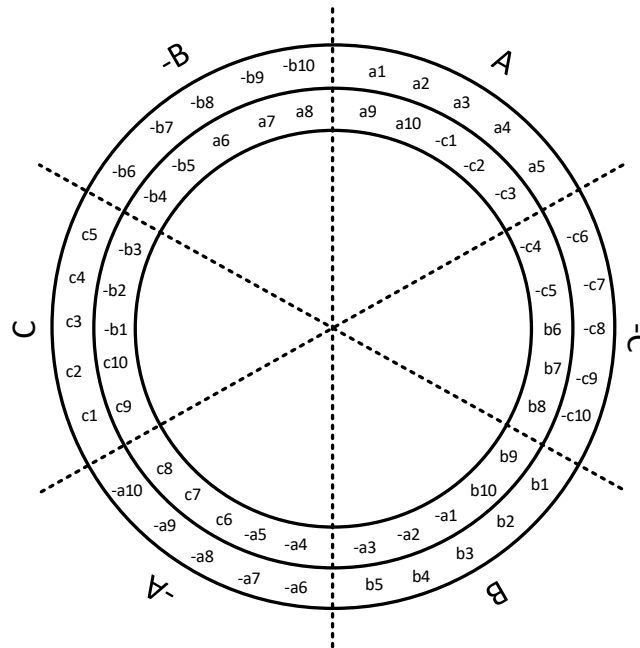


Figure 1: Stator Side of the AC Machine

Part A: Answer the following by also briefly explaining how you determined them:

- What is the pole number?
- What is the slot number?
- What is the slot angle in degrees?
- What is the phase belt angle in degrees?
- What is the number of slots per phase per pole?
- What is the coil span (pitch) in electrical radians?
- What is total number of series turns per phase?
- What is the distribution factor for the fundamental component?
- What is the chording factor (pitch factor) for the fundamental component?
- What is the winding factor for the fundamental component?
- What is the mechanical speed of the rotating MMF (in rpm) if the stator windings are excited with balanced 3-phase currents at 50 Hz

Part B: The stator of the machine given in Part A is excited by balanced three phase currents with peak value of 2A (\hat{I}) and frequency of 50 Hz (f) where the phase sequence is A-B-C and phase-a current can be considered as following:

$$i_a(t) = \hat{I} \cos(2\pi ft)$$

- At $t = 0$, obtain the MMF waveforms due to phase-a (MMF_A), phase-b (MMF_B), phase-c (MMF_C) currents (against position or slot number) separately and obtain the resultant MMF (MMF_TOTAL).
- Repeat Part (a) at $t = 6.67$ msec.
- Repeat Part (a) at $t = 10$ msec.
- Repeat Part (a) at $t = 13.33$ msec.
- Sketch MMF_A at these four different instants on the same axis using **subplot** function. Comment on the result.

Q.2. Suppose that the stator windings of a 4 pole AC machine are supplied by balanced **three phase AC currents** as given below:

$$i_a(t) = \hat{I} \cos(2\pi ft)$$

$$i_b(t) = \hat{I} \cos(2\pi ft - 2\pi/3)$$

$$i_c(t) = \hat{I} \cos(2\pi ft - 4\pi/3)$$

and the rotor (on which a single coil is wound) is rotated at N_r in the **same direction with the MMF** produced by the stator. Find the frequency of the voltage seen on the rotor coil for the following cases:

a. $f = 50$ Hz & $N_r = 1300$ rpm

b. $f = 50$ Hz & $N_r = 900$ rpm

If now the rotor rotation is reversed; what will be the frequency of the voltage seen on the rotor coil for the following cases:

c. $f = 50$ Hz & $N_r = 1300$ rpm

d. $f = 50$ Hz & $N_r = 900$ rpm

Explain all your steps in detail!