Simulation of Induction Machines Using Phase Variables and the Explicit Inverse Inductance Matrix

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ABSTRACT

In the simulation of the behaviour of 3-phase induction machines, one can elect to use the d-q axis model or a model based directly on the individual phase variables (normally currents or flux linkages). It is well established that there are many situations in which the d-q axis model is not adequate. In the past, authors dealing with the simulation of induction machines have consistently taken exception to the fact that the inverse of the inductance (6x6) matrix must be found at every step of the simulation and some have devised transformations of the variables which avoid the need to compute this inverse numerically. It is shown here that the inverse of the inductance matrix is known explicitly and that a highly efficient simulation of the induction machine can be implemented using only the easily-understood phase equations without any transformations.

LIST OF SYMBOLS

a, b, c : suffixes denoting phase quantities
s, r : suffixes denoting stator and rotor, respectively
r_s, r_r : three phase stator and rotor resistances, respectively
i : instantaneous phase current
f : constant relating friction & windage torque to speed.
J : inertia of machine rotor (referred to electrical speed frame)
L_{ss} : three phase stator self inductances
L_{rr} : three phase rotor self inductances
L_{sm} : mutual inductance between stator phases
L_{rm} : mutual inductance between rotor phases
M_{sr} : mutual inductance between three phase stator and rotor circuits
T_e : torque transmitted across the airgap (referred to electrical speed frame)
T_l : torque transmitted along shaft to load (related to electrical speed frame)
v : instantaneous phase voltage
ψ : instantaneous flux linkage
: electrical angle denoting instantaneous rotor position, radians
i : vector of phase currents
L : inductance matrix
R : resistance matrix

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