LIST OF SYMBOLS

ρ	a general parameter

General Use of Subscripts

ρ_d, ρ_q	for d and q axis quantities (individual machine reference)
ρ_D, ρ_Q	for D and Q axis quantities (network reference)
ρ_s, ρ_r	for stator and rotor quantities (e.g. induction motor)
ρ_b	for base values
ρ_u	for per unit values
ρ_o	quiescient value

Generator/Infinite Bus Voltages and Angles

v_f	field voltage
v_s, v_t	stator terminal voltage
v_{so}, v_{to}	quiescent value of stator terminal voltage
v_a, v_b, v_c	instantaneous line-to-neutral voltages in each phase
V_S	column vector of v_a, v_b, v_c
v_d, v_q, v_o	d, q, and zero axis components of voltage
v_{do}, v_{qo}	d and q axis components of quiescent value of voltage
v_D, v_Q	D and Q axis components of voltage
V_d, V_q	phasor form of v_d and v_q
V_B	column vector of "Blondel" transformed voltages
V_P	column vector of "Park" transformed voltages
V_g	voltage behind leakage reactance
V_{IB}	infinite bus voltage
V_b, V_u	base and per unit values of voltage
E_g	ficticious voltage used to locate quadrature axis
E_o	roltage behind synchronous reactance
δ	rotor angle - amount field centreline (q-axis) leads stator terminal voltage
θ	power factor angle (direction?)
β	angle between stator current and -ve d-axis
E_q'	voltage behind transient reactance (dynamic field model)
E_o'	voltage behind transient reactance (fixed field model)
δ'	angle between E' and V_t

Generator Currents

I_s	stator terminal current
i_a, i_b, i_c	instantaneous stator currents in each phase
I_S	column vector of i_a, i_b, i_c
i_d, i_q, i_o	d, q, and zero axis components of stator current
i_{do}, i_{qo}	d and q axis components of quiescent value of stator current
i_D, i_Q	D and Q axis components of current
I_d, I_q	phasor form of i_d and i_q
i_{kd}, i_{kq}	d, and q axis damper winding currents
i_f	field winding current
I_f'	field current in equivalent stator amperes
n'	field current ratio (ac/dc)

I_B column vector of "Blondel" transformed stator currents
I_P column vector of "Park" transformed stator currents
I_b, I_u base and per unit values of current

Generator Powers

P_s synchronizing power coefficient
p instantaneous power
P real (active) power
Q imaginary (reactive) power
S complex (apparent) power
S_b, S_u base and per unit values of power
$S_{3\phi}$ three phase complex power

Resistances

R_s stator winding resistance
R_S the set of stator winding resistances
R_f field winding resistance
R_{kd}, R_{kq} damper winding resistances
R_L line resistance
G shunt conductance

Inductances and Capacitance

$L_{s\ell}$ stator winding leakage inductance
L_{aa}, L_{bb}, L_{cc} stator winding self inductances
L_{ab}, L_{bc}, L_{ca} stator winding mutual inductances
L_S the set of stator inductances
$L_{f\ell}$ field winding leakage inductance
L_{ff} field winding self inductance
L_m magnetizing inductance
L_{af}, L_{bf}, L_{cf} stator-field winding mutual inductances
L_{fs} the set of stator-field mutual inductances
$L_{kd\ell}$, $L_{kd\ell}$ damper winding leakage inductances
L_{kd}, L_{kq} damper winding self inductances
$L_1 \rightarrow L_5$ inductance constants
L_L line inductance
C shunt capacitance

Reactances

X_{sl} stator winding leakage reactance
X_{md} d-axis magnetizing reactance (referred to stator winding)
X_d d-axis reactance ($X_d = X_{md} + X_{sl}$)
X_d' d-axis transient reactance
X_d'' d-axis subtransient reactance
X_{mq} q-axis magnetizing reactance (referred to stator winding)
X_q q-axis reactance ($X_q = X_{mq} + X_{sl}$)
X_q' q-axis transient reactance
X_q'' q-axis subtransient reactance
X_r rotor reactance (induction motor)
X_s stator reactance (induction motor)

X_L	line reactance
B	shunt susceptance

Impedances

Y	shunt admittance
Z_L	line impedance
Z_b, Z_u	base and per unit values of impedance

Generator Time Constants

τ'_d, τ'_{do}	short and open circuit transient time constants
τ''_d, τ''_{do}	short and open circuit d-axis subtransient time constants
τ''_q, τ''_{qo}	short and open circuit q-axis subtransient time constants

Flux Linkages

ψ_f	field flux linkage
ψ_d	d-axis stator flux linkage
ψ_q	q-axis stator flux linkage
ψ_{kd}	d-axis damper flux linkage
ψ_{kq}	q-axis damper flux linkage
ψ_b, ψ_u	base and per unit values of flux linkage

Shaft (Rotor) System

α	instantaneous rotor angle relative to stator reference
ω	rotor speed, frequency
ω_b, ω_o	base value of speed (synchronous speed)
Ω	set of rotor speeds
δ_e, ω, α	rotor angle, speed, and acceleration using electrical radians
δ_m, ω_m	rotor angle and speed using mechanical radians
N_p	number of poles
T	torque
T_b, T_u	base and per unit values of torque
T_a	acceleration torque
T_d	damping torque
T_e	electrical torque
T_m	mechanical torque
J	polar moment of inertia
M	inertia constant
W_k	stored energy
H, $H_1 \rightarrow H_5$	per unit inertia constants
W_k	stored energy
D, $D_1 \rightarrow D_5$	per unit damping coefficients
$S_{12} \rightarrow S_{45}$	shaft stiffness coefficients
$\delta_1 \rightarrow \delta_5$	shaft inertia segment angles
$n_1 \rightarrow n_5$	shaft inertia segment per unit speeds

Magnetic Circuit

$\mathscr{F}$	magnetic potential
$\Re$	magnetic reluctance
ϕ	magnetic flux

B	magnetic flux density
μ_o, μ_r	magnetic permeability: free space, relative
ℓ, a	length and cross section area of magnetic path
N	number of turns

Exciter/Stabilizer/Voltage Regulator

K_E	exciter gain
τ_E	exciter time constant
τ_R	transducer time constant
K_A	amplifier gain
τ_A	amplifier time constant
K_F	feedback gain
τ_F	feedback time constant
S_E	saturation function
K_Q	washout circuit gain
τ_Q	washout circuit time constant
τ_a, τ_x	compensator time constants
v_a, v_b, v_x, v_y	compensator variables
V_{ref}	reference voltage input
v_v	voltage transducer output
v_{fd}	exciter output voltage

Governor/Turbine

K_g	governor gain
τ_1	hydraulic speed relay time constant
τ_3	hydraulic servomotor time constant
τ_W	water time constant (also τ_5)
g, g_1, g_2, g_3	governor output powers
τ_{SR}	thermal speed relay time constant
τ_{SM}	thermal servomotor time constant
τ_{CH}	steam chest time constant
τ_{RH}	steam reheat time constant
τ_{CO}	steam crossover time constant
F_{HP}, F_{IP}, F_{LP}	steam fractions
P_{HP}, P_{IP}, P_{LP}	steam fraction powers
P_m	turbine power output
P_{ref}	reference power input

Power System Loads/Induction Motors

v_{ds}, v_{qs}	d and q axis components of stator voltage
v_{dr}, v_{qr}	d and q axis components of rotor voltage
i_{ds}, i_{qs}	d and q axis components of stator current
i_{dr}, i_{qr}	d and q axis components of rotor current
ψ_{ds}, ψ_{qs}	d and q axis components of stator flux linkage
ψ_{dr}, ψ_{qr}	d and q axis components of rotor flux linkage
s	slip (per unit speed difference between rotating field and rotor)
L_m, X_m	magnetizing inductance and reactance (for non-salient rotor)
X_r	rotor reactance (induction motor)
X_s	stator reactance (induction motor)

X_s'	transient reactance for induction motor

Matrix/Vector Terminology

$\boldsymbol{B}$	the "Blondel" transformation matrix
$\boldsymbol{P}$	the "Park" transformation matrix
U	the unit matrix

Miscellaneous

ζ	damping ratio
ω_n	undamped natural frequency
$K_1 \rightarrow K_6$	constants in D&C model
K_d, K_s	damping and synchronizing torque coefficients
T_d, T_s	damping and synchronizing torque components
λ_i	i^{th} eigenvalue
T_i	i^{th} eigenvector
V_i	i^{th} transposed eigenvector
$\dot{}$	(dot superscript) or $\frac{d}{dt}$ first time derivative
$\ddot{}$	(double dot superscript) or $\frac{d^2}{dt^2}$ second time derivative

Use of units - assume per unit unless otherwise stated