Second Exam Spring 1993

Problem #1
25 points

The following tests were performed on a 3ϕ, 60 Hz, 6 pole synchronous generator at a speed of 1200 rpm:

$\lvert\bar{I}_a\rvert = 0$	$I_f = 2A$	$\lvert\bar{V}_t\rvert = 120$ v. l-n
$\lvert\bar{I}_a\rvert = 5A$	$I_f = 1A$	$\lvert\bar{V}_t\rvert = 0$

Find the real and reactive power supplied by this generator when $I_f = 2.5A$, $\lvert\bar{I}_a\rvert = 5A$, $\lvert\bar{V}_t\rvert = 120$ v. l-n. (Neglect r_a)

(Hint: $\sin^2 x + \cos^2 x = 1$)

Problem #2
25 points

A 277 v. l-n, 3ϕ synchronous motor is running with no real power load. When the field current is 1A, it draws 3000 vars (3ϕ) from the network. When the field current is 3A, it supplies 3000 vars (3ϕ) into the network. (Neglect r_a)

a) What will it do if the field current is reduced to zero?

b) What is the minimum field current which can be used if it is loaded at 3000 watts?

Problem #3
25 points

A shunt DC generator is driven by a wind turbine which may turn anywhere between 100 RPM and 200 RPM. If the generator has an internal voltage which may be approximated at 150 RPM by:

$$E_a = 10 + 130 I_f$$

compute the range of values for a field rheostat needed to control the terminal voltage at 230 volts for all speeds. The shunt field winding resistance is 45Ω. (Neglect R_a)

Problem #4
25 points

A 230v DC shunt motor has a no-load speed of 1300 RPM. At this speed, its internal voltage may be approximated by:

$$E_a = 14 + 180 I_f$$

The armature resistance is 1Ω. Your starting box is broken.

(a) What value of resistance should be added in series with your 230 V. supply to limit the terminal current to 10A during startup?

(b) What speed will the motor reach with your resistor in the terminal circuit?