Exam II Spring 1997

**Problem #1**
**20 Points**

A 4 pole, 60 Hz, 3$\phi$ synchronous generator is being driven by a turbine at a constant speed of 1800 Rpm. Under open-circuit conditions, a field current of 3 Amps produces a terminal voltage of 480 v (l-l). Under short-circuit conditions, a field current of 2 Amps produces a line current of 10 Amps. What field current is needed to maintain 480 v (l-l) under a 10 Amp load at unity power factor? Neglect Saturation and $R_a$

**Problem #2**
**30 Points**

The machine of problem #1 is being run as a motor on a 480 v (l-l) source. You would like the motor to deliver a shaft load of 20 HP. Find:

(a) The value of field current which will result in minimum armature current.

(b) The minimum value of field current for which the machine will remain stable.

**Problem #3**
**20 Points**

A self-excited shunt dc generator produces a voltage of 100V when its field resistance is 100Ω and the speed is 1200 RPM. It produces a voltage of 120 V when its field resistance is 80Ω and the speed is 1200 RPM. Give your best guess of what you think the terminal voltage would be with 90Ω of field resistance and a speed of 1400 RPM.

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**Problem #4**
**30 Points**

A 230 V shunt dc motor has $R_f = 150\Omega$, $k_f^{SH} = 1.2\ \Omega\text{sec/rad}$, $J = 0.2\ \text{kg m}^2$, $R_a = 2\Omega$. At <u>no load</u>, Newton's 2nd Law for the motor shaft dynamics is:

$$J\frac{dw}{dt} = T_{TO_{shaft}}$$

The motor is at standstill and you want to start it with full voltage by adding series resistance to the <u>armature</u> so the terminal current is less than 20A at startup.

(a) Find $T_{TO_{shaft}}$ using the appropriate starting resistor and predict $w(.01)$ and $w(.02)$ using Euler's method with $h = .01$ sec, when $V_t = 230$ V is applied at $t = 0$.

(b) What is $w$ as $t \to \infty$?

(Neglect Saturation and assume currents change instantly)