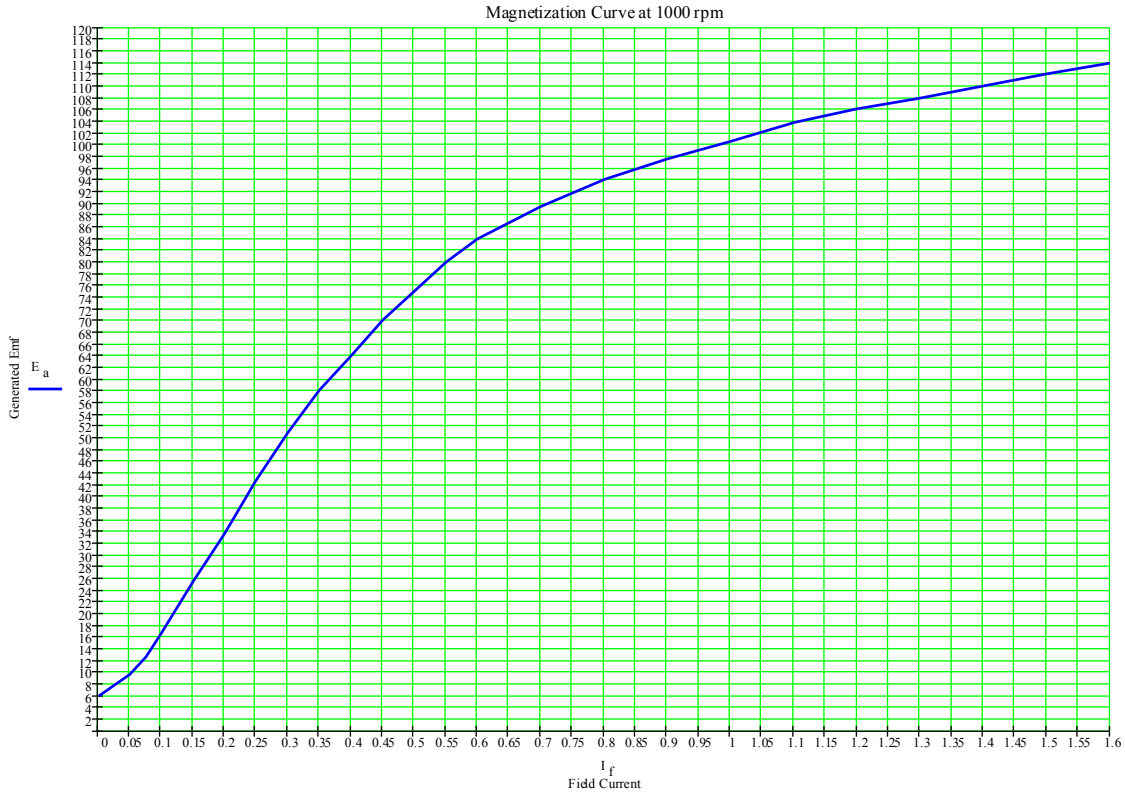
Name: …….

TEST #2 **SEE 3433/SKEE4633** **1 hour 15 minutes**

Q1. The dc machine (10 kW, 100 V, 1000 rpm, R_a = 0.1 Ω, R_{fw} = 80 Ω, N_f = 750 turns) is connected to a 100 V dc supply and is operated as a dc shunt motor. At no-load condition, the motor runs at ω_m = 1000 rpm and I_a = 10 A.



(a) Find the speed in rpm when the rated current flows in the armature. Consider that the air gap flux is reduced by 6 % when rated current flows in the armature because of armature reaction. (2 marks)

(b) Find the speed in rpm when the rated current flows in the armature. Consider that the armature reaction effect in equivalent field current, $I_{f(AR)}$ = 0.10 A. (2 marks)

(c) How many series field turns per pole should be added to make this machine into a differential compound motor whose speed will be 1050 rpm at full load. Neglect resistance of the series field winding. Assume $I_{f(AR)}$ = 0.10 A. (2 marks)

Q2. A 300 V, 10 kW series motor is mechanically coupled to a fan and draws 30 A, and runs at 600 rpm when connected to a 300 V supply with no external resistance connected to the armature circuit (i.e. R_{ael} = 0). The torque required by the fan is given by $T \propto \omega^{1/2}$. R_a = 0.60 Ω and R_{sr} = 0.3 Ω. Neglect armature reaction and rotational loss.

(a) Draw an equivalent circuit of the series DC motor, which would be used for steady-state calculations. Label all key quantities. (2 marks)

(b) Determine the back emf, E_{a1}, the power delivered to the fan, P_1, and torque developed by the machine, T_1. (3 marks)

(c) The speed is to be reduced to 300 rpm by inserting a resistance, R_{ae2} in the armature circuit. Determine the value of this resistance. Also, determine, the power delivered to the fan, P_2. (3 marks)

Q3. A 3-phase, Δ-connected, 415-V, 50 kW, 50 Hz, 727 rpm, 8-pole induction motor is operating at rated conditions has an efficiency of 87 percent and draws a line current of 98 A. The motor losses are given as follows:

The rotor copper loss = 1680 W
Assumed the core loss is combined with rotational loss.

Determine the following:
(a) Input power (1 mark)
(b) Total losses (1 mark)
(c) Air-gap power (1 mark)
(d) Slip speed (1 mark)
(e) Power factor (1 mark)
(f) Rotational loss (1 mark)
(g) Output Torque (1 mark)

Q4. A 3-phase, 415 V (line to line), 50 Hz, 6-pole, Δ-connected, induction motor has the following equivalent circuit constants in ohms per phase.

$R_1 = 1.4\ \Omega$, $R_2' = 0.6\ \Omega$, $X_1 = 2\ \Omega$, $X_2' = 1\ \Omega$, and $X_m = 50\ \Omega$.

The total windage and friction losses of the motor may be assumed to be constant at 275W, independent of load and speed.

(a) Calculate the air gap power and the output power for a slip of 0.035. (3 marks)
(b) Calculate the line current and the torque at starting. (3 marks)
(b) Calculate the power factor and rotor current at the maximum torque. (3 marks)

Use the approximate equivalent circuit.