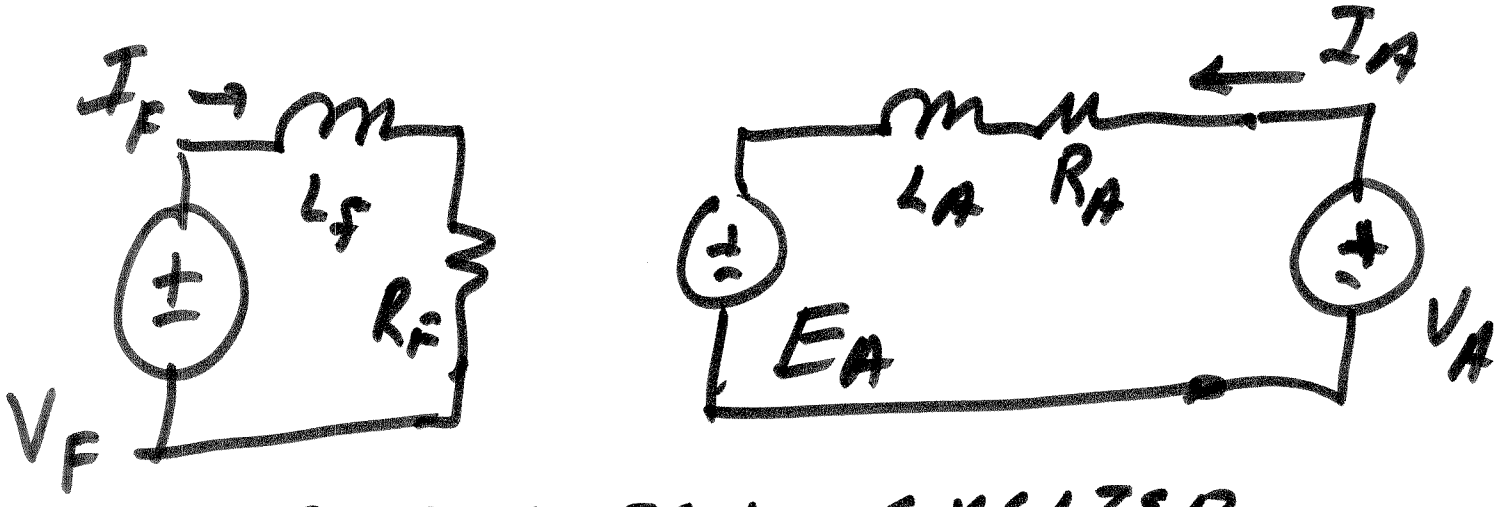
ECE 320 & ECE 329

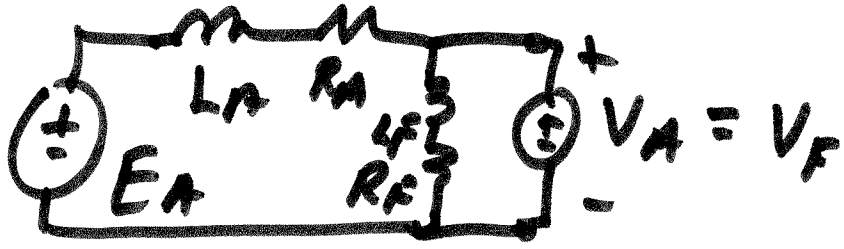
ENERGY SYSTEMS I
BACKGROUND STUDY IN ENERGY SYSTEMS

SESSION no. 25

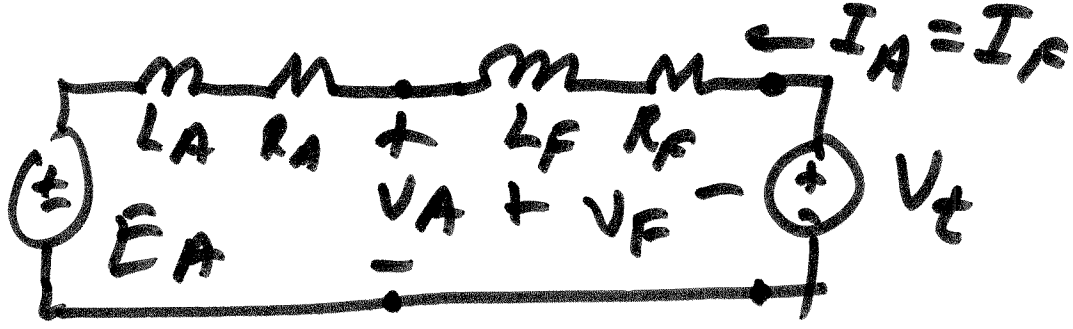
DC MACHINES (Motors)



SEPARATELY EXCITED



SHUNT



SERIES

#1 $T_e = K \phi_d I_A$

#2 $E_A = K \phi_d \omega$

#3 $V_A = E_A + I_A R_A$

#4 $P_m = E_A I_A = T_e \omega$

EXAMPLE

SEPARATELY EXCITED MOTOR

$V_A = 125\,V$ $\quad R_A = 0.02\,\Omega$ $\quad P_{loss_M} = 0\,W$

$\omega = 3000\,RPM = 50\,\frac{rev}{sec} \Rightarrow P_{out} = 0$

FIND I_A, P_{in}, $P_m = E_A I_A = T_e \omega$

WHEN $V_A \Rightarrow 128\,V$

NO LOAD $\Rightarrow T_e = 0$; $T_e = K\phi I_A$

$E_A = V_A - I_A R_A$ $\quad \Rightarrow I_A = 0$

$E_A = 125V - (0A)(0.02\Omega)$

$E_A = 125V$

LOAD

$V_A = 128V \qquad E_A = 125V$

$I_A = \dfrac{V_A - E_A}{R_A}$

$I_A = \dfrac{(128 - 125)V}{0.02\Omega} = 150A$

$$P_{in} = V_A I_A = (128\,V)(150\,A)$$

$$P_{in} = 19.2\,kW$$

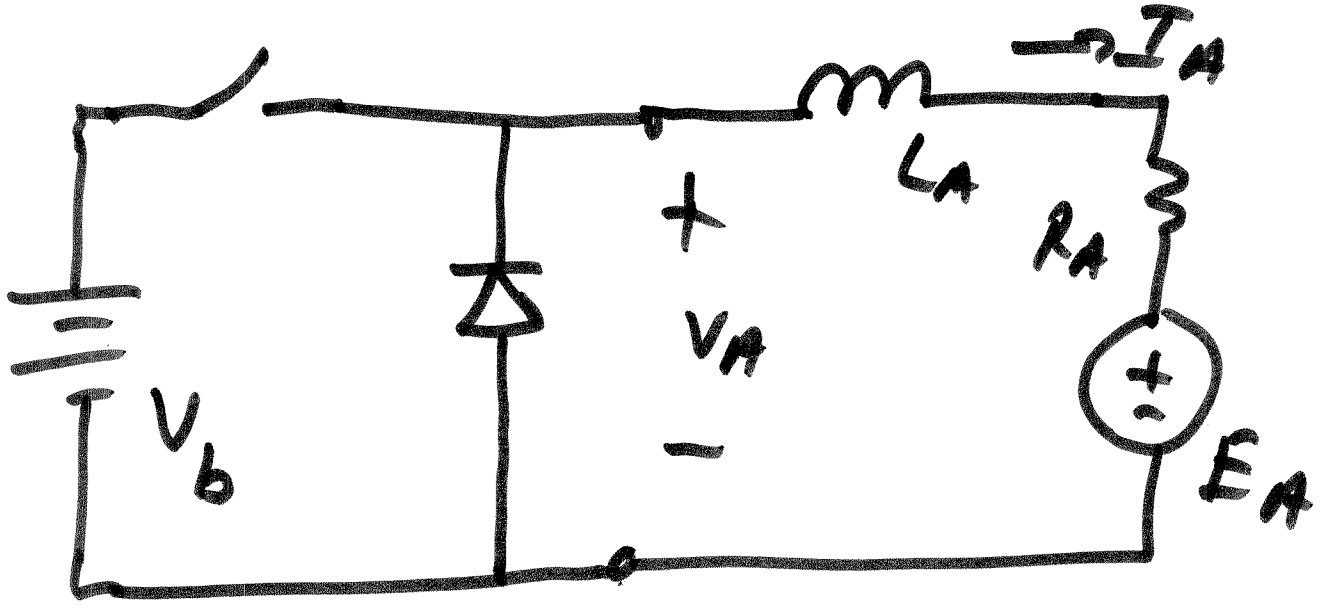
$$P_m = E_A I_A = (125\,V)(150\,A)$$

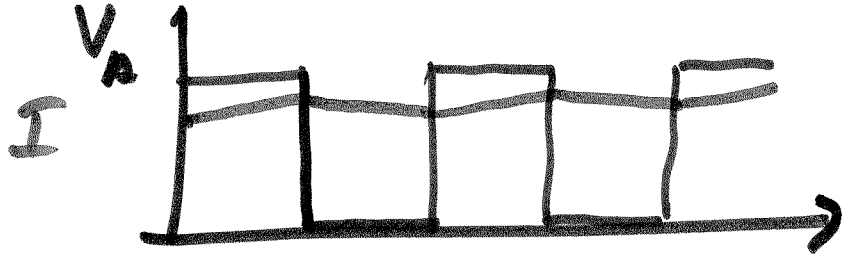
$$P_m = 18.75\,kW$$

$$P_{loss} = I_A^2 R_A = (150\,A)(0.02\,\Omega)$$

$$P_{loss} = 450\,W$$

$$T_e = \frac{P_m}{\omega} = \frac{18.75\,kW}{2\pi\left(50\,\frac{rev}{sec}\right)} = 59.7\ N\text{-}m$$





BUCK DC-DC CONVERTER

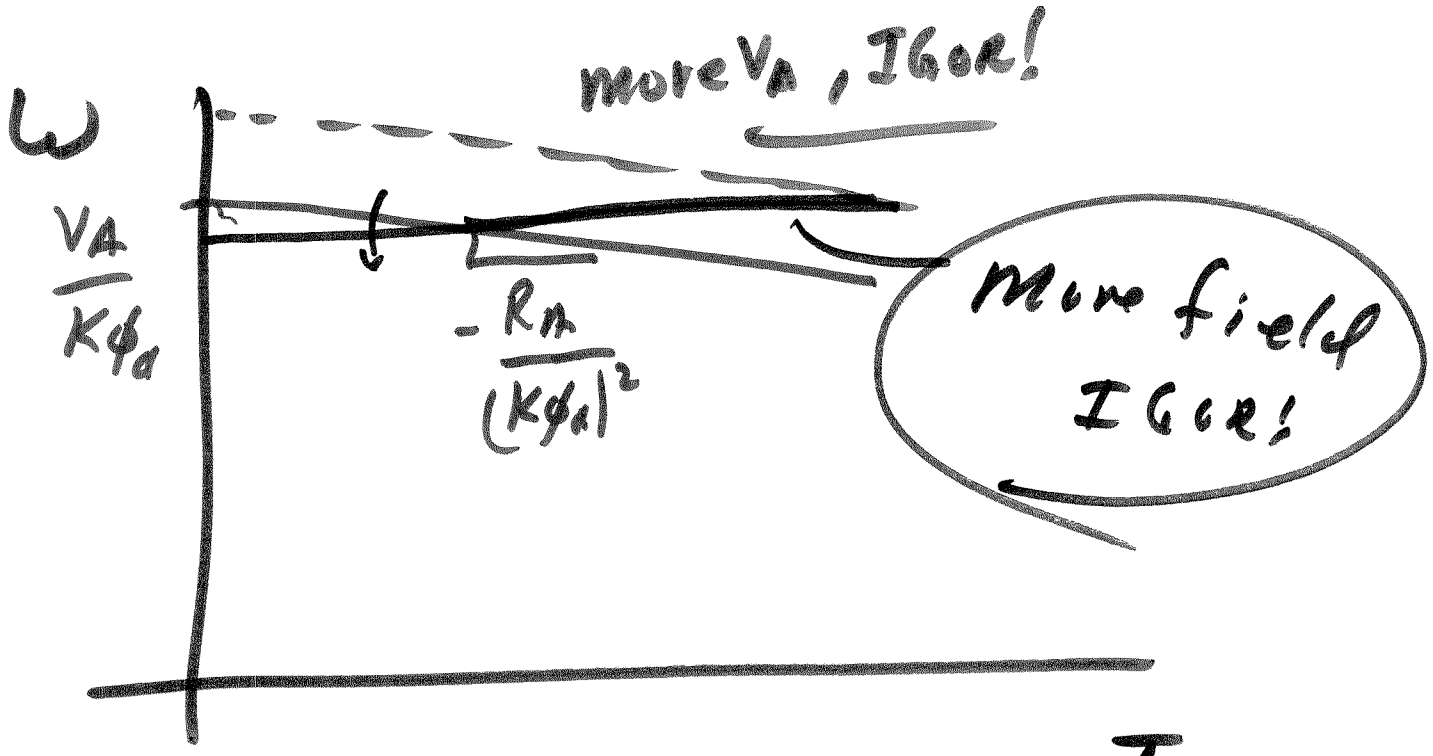
SEPARATELY EXCITED DC MACHINE

$$V_A = I_A R_A + E_A$$

$$E_A = K \phi_d \omega \qquad T_e = K \phi_d I_A$$

$$V_A = \frac{T_e}{K\phi_d} R_A + K\phi\omega$$

$$\omega = -\frac{R_A}{(K\phi_d)^2} T_e + \frac{V_A}{K\phi_d}$$



FIELD WEAKENING...
MORE SPEED!

$$E_A = K \phi_d \omega$$

$$V_A = E_A + I_A R_A$$

↑ Constant

↑

IF E_A collapses

I_A ↑↑↑

$T = K \phi_d I_A$

MAGNETIZATION CURVE

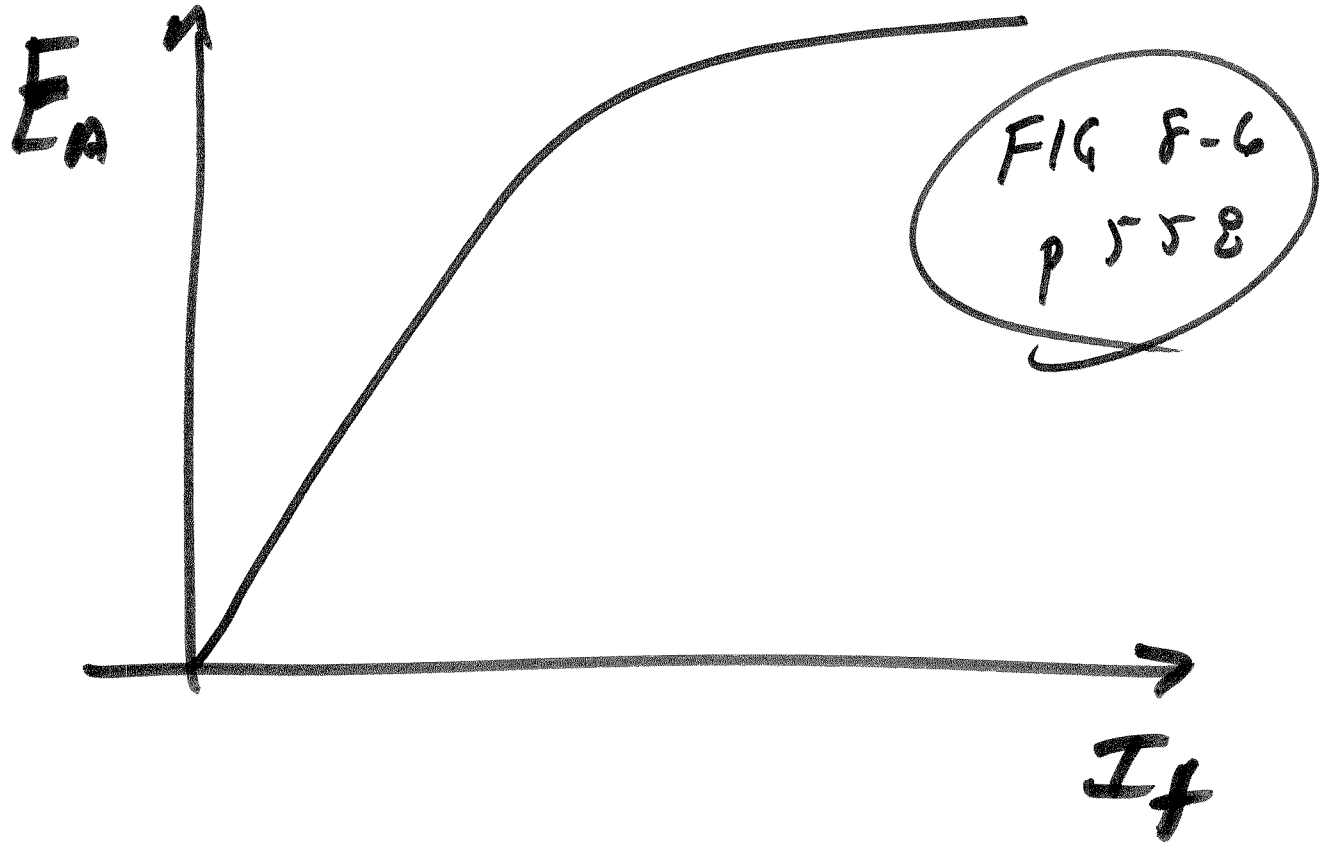


FIG 8-6
p 358

ECE 320

Energy Systems I

Lesson 25

DC Motors

Recitation Lesson 28

E_A=generated voltage, back emf

E_A, E_G, E_{AF},

How do I change the terminal voltage?

Transformer…it's DC…

Rheostat (shunt); voltage divider…