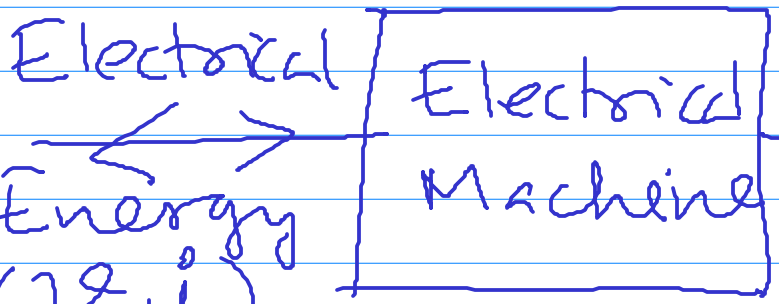
Electoic Drives



DC
AC
415V, 3ϕ AC
220V, 1ϕ AC
220V DC
→ Induction
→ Synchronous

BLDC – Bouchless DC Machine
→ AC Machine

→ Permanent Magnet

PMSM – Permanent Magnet Synchronous Machine

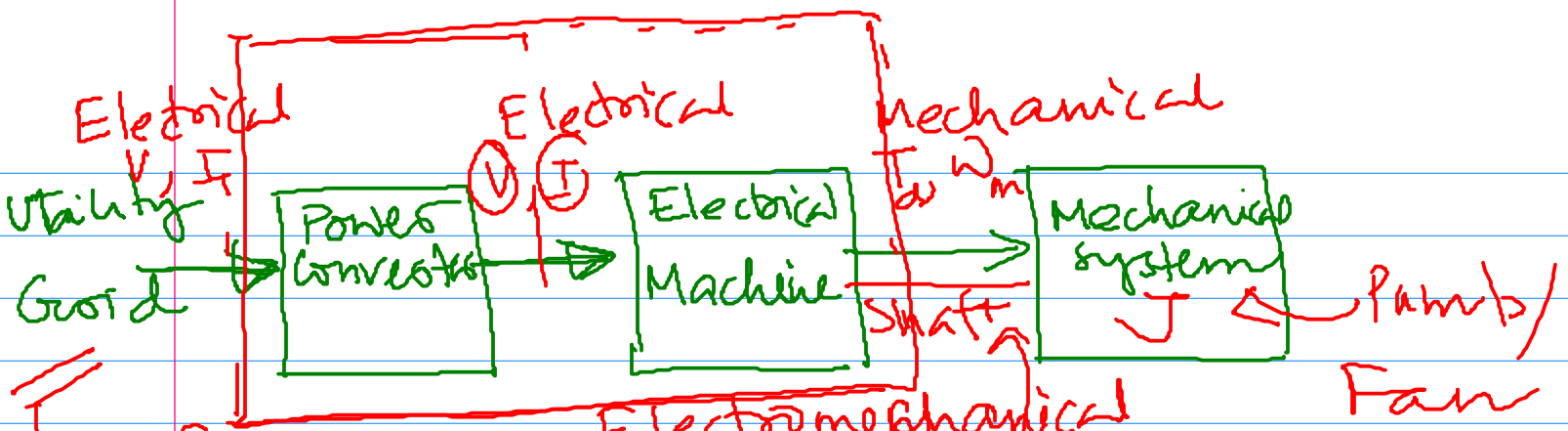
From utility Machine grid supplug these machines (BLDC, PMSM) can't be run.

→ Speed Control
→ Position Control
→ AC Servo Machine

Application Requirements

T_d: Torque developed by a machine

Synchronous Machine
20A
40A



Power Processing $\eta = 1$

Electromechanical Energy Conversion

$T_d = \phi i$

unchange but current is changed by changing the ϕ

Speed/Position → Torque control → i control

415V (RMS)

Vgrid

fs, 50Hz

V, f → Voltage Source Inverter

I, f → Current Source Inverter

Electric Drives

Control System

(1) Power Converter Topologies

(2)

* dynamics → speed of transient response, stability
* steady state → steady state error (position error)
* Efficiency criterion $\eta = 1$
* Matching the source voltage to the machine voltage

Books : Power Electronics and AC Drives
B. K. Bose
Prentice Hall Year: 1986

Control of Electrical Drives
W. Leonhard
Narosa Publications

Tests : 3 Class Tests
3 Assignments.

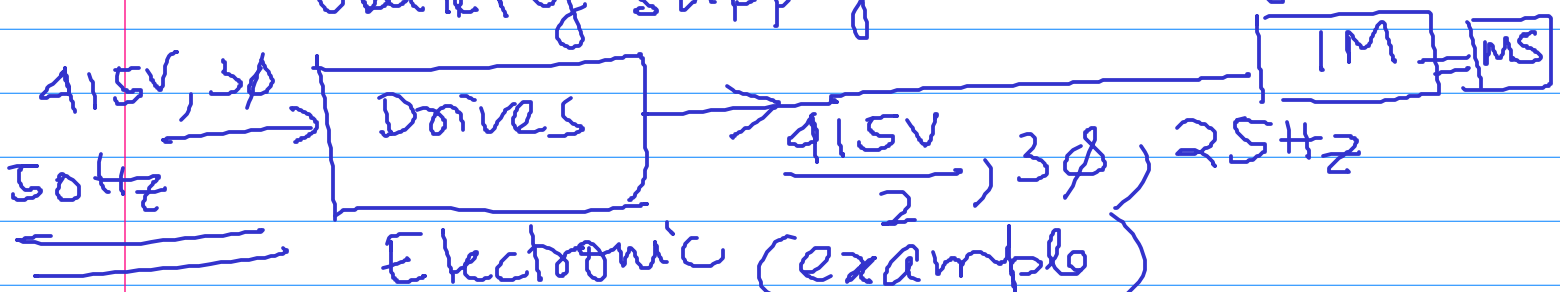
An application of electric drives

→ Induction Machine Drive in Pump Applications

VFD : Variable Frequency Drive (Induction Machine Drive)

415V, 3Φ, 50Hz is used as a supply

Utility supply



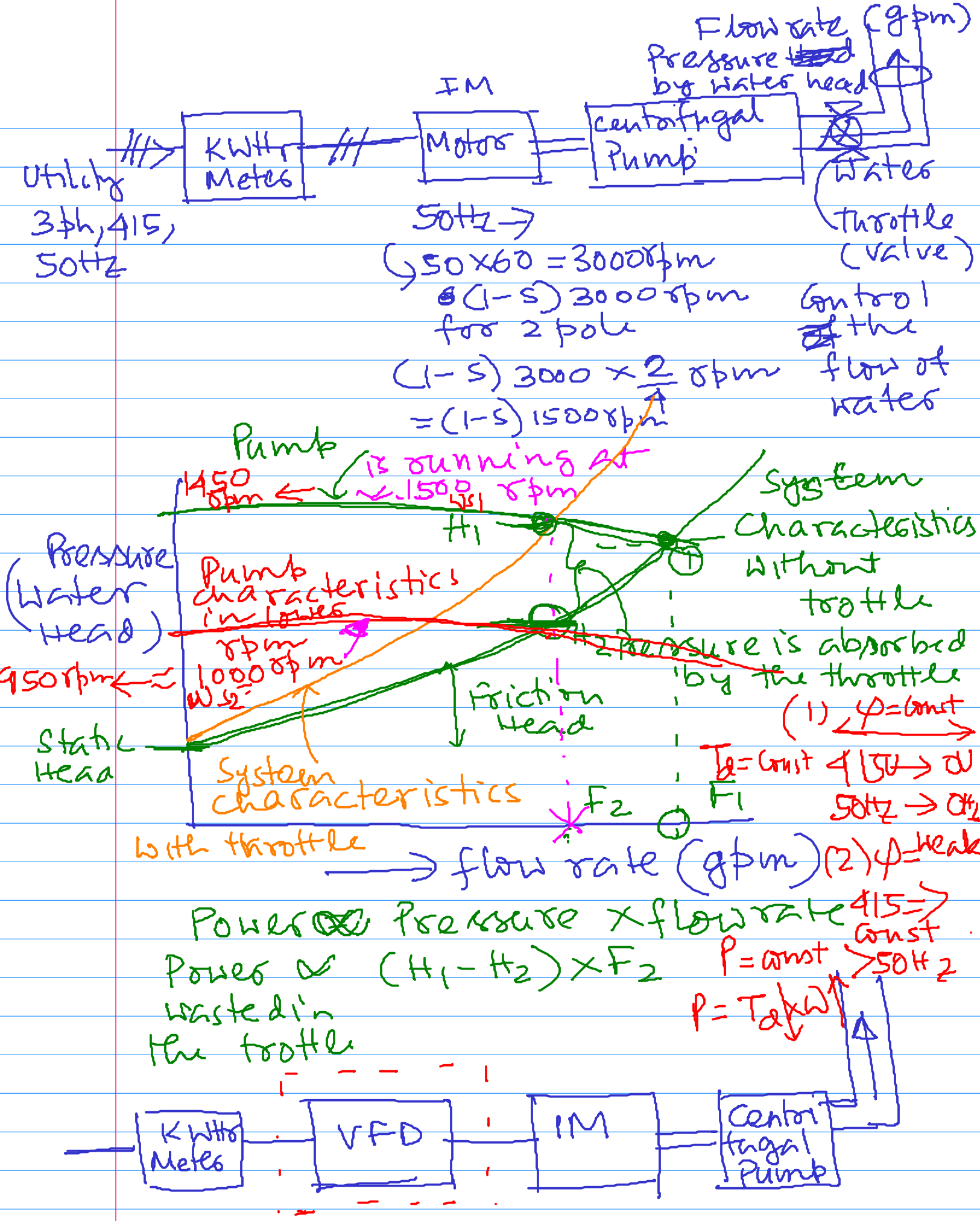
Electronic Part (example) 415V/2, 3Φ, 50Hz ←

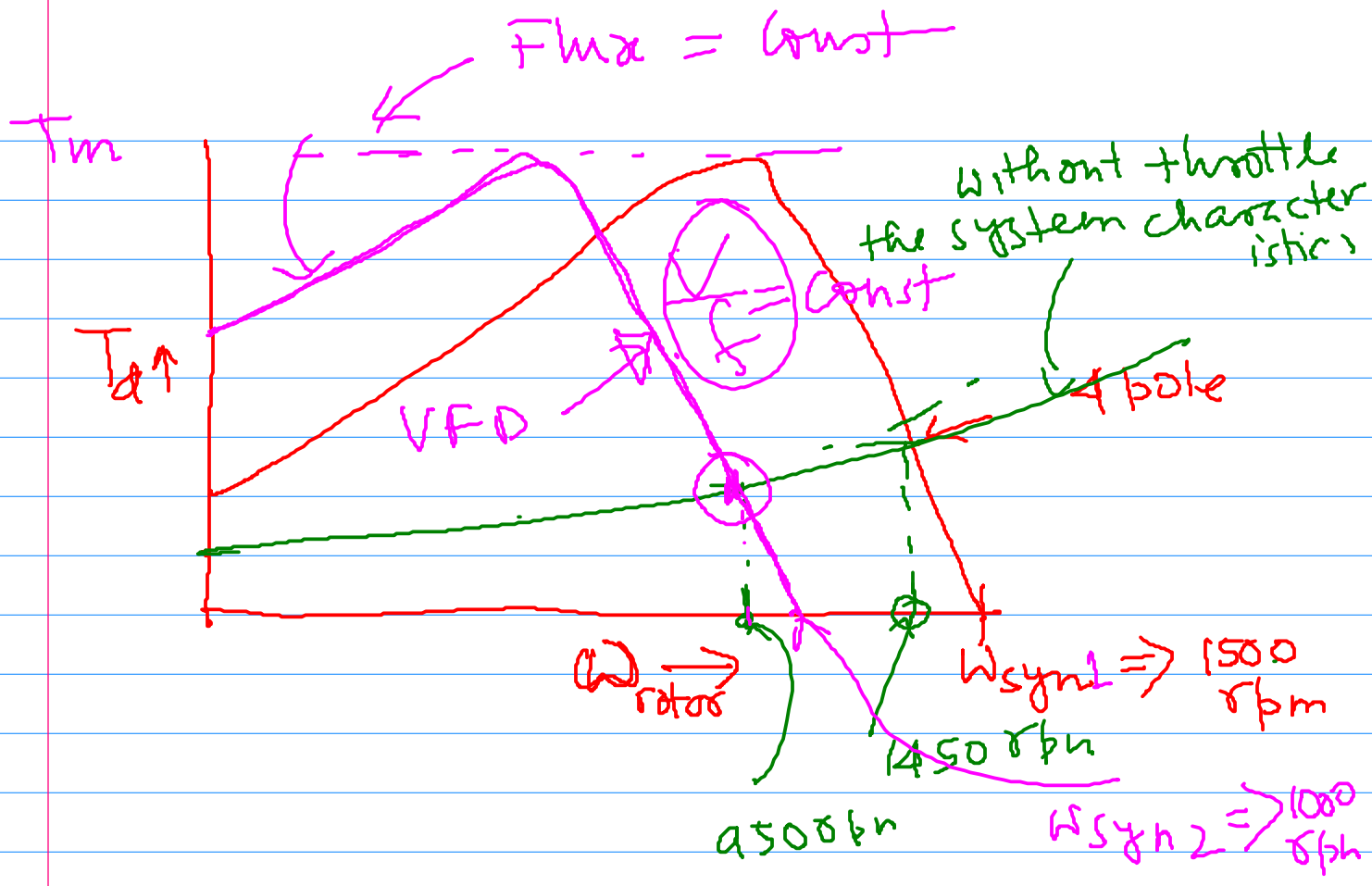
underfluxing machine

$$E_{ph} \simeq V_{ph} = 4.44 f (B_m A_c N_{ph})$$

Φ_m

$\frac{V_{ph}}{f}$ → Φ_m is constant


Flow rate (gpm)
Pressure by water head
IM
KWHr Meter
Motor
Centrifugal Pump
Utility 3ph, 415, 50Hz
50Hz →
50 x 60 = 3000 rpm
(1-S) 3000 rpm for 2 pole
(1-S) 3000 x 2 rpm
= (1-S) 1500 rpm
Water throttle (valve)
Control the flow of water
Pump
1450 rpm
is running at ~1500 rpm
H1
System Characteristics without throttle
Pressure (Water Head)
Pump characteristics in lower rpm
950 rpm ≈ 1000 rpm
W2
H2
Pressure is absorbed by the throttle
Friction Head
Static Head
System characteristics
F2
F1
With throttle
(1) φ=Const
Td=Const
V → dV
50Hz → dV1
→ flow rate (gpm) (2) φ=weak
Power ∝ Pressure x flow rate
415 => Const
P=const
>50Hz
Power ∝ (H1 - H2) x F2
wasted in the throttle
P = Td x W
KWHr Meter
VFD
IM
Centrifugal Pump


Flux = Const
Tm
Td
VFD
V/f = Const
without throttle the system characteristics
4 pole
ω rotor
Wsync1 ⇒ 1500 rpm
1450 rpm
1500 rpm
Wsync2 ⇒ 1000 rpm