

Lecture 4: Electrical Test Equipment



Recall From Lecture 3

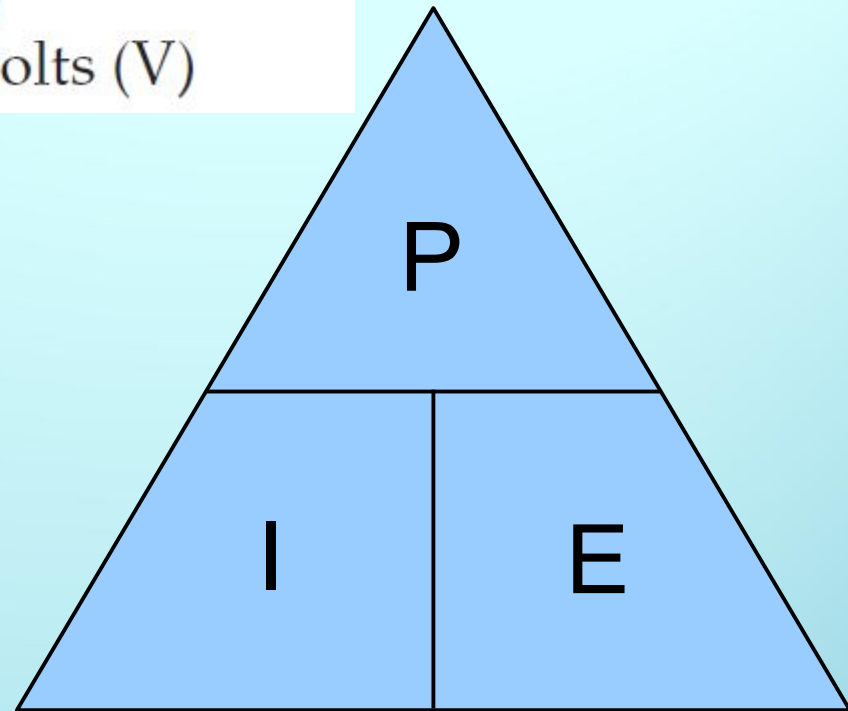
Electrical Power:

$$P = IE \left(I = \frac{P}{E} \text{ or } E = \frac{P}{I} \right) \quad (\text{Eq. 3.2})$$

where P = power, in watts (W)

I = current, in amperes (A)

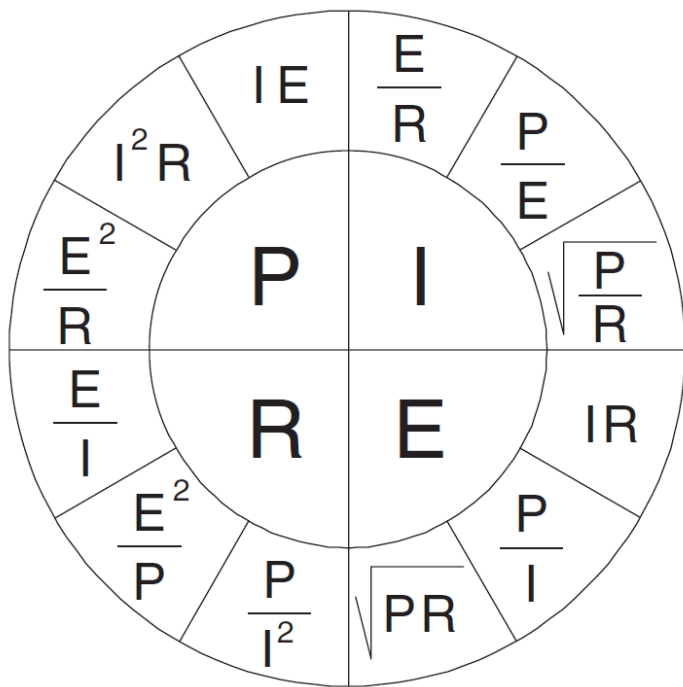
E = electrical pressure, in volts (V)



Recall From Lecture 3 cont'd

Electrical Power:

PIRE wheel



All you REALLY need to remember:

- $E = I R$
- $P = I E$
- algebra

FIGURE 3-2 PIRE wheel.

Recall From Lecture 3 cont'd

- Relationship with Power
 - If Power not constant with time $Energy = \int P(T) dT$
 - If Power constant $Energy = PT$
- System Efficiency:

$$\% \text{ Eff} = \frac{\text{Useful energy output}}{\text{Total energy input}} \times 100 \quad (\text{Eq. 3.9})$$

$$\% \text{ Eff} = \frac{\text{Power output}}{\text{Power input}} \times 100 \quad (\text{Eq. 3.10})$$

Recall From Lecture 3 cont'd

Mechanical Power:

- Equation considering SI units:

$$P = \tau \omega$$

Power (W) → ← Angular speed (radians/s)
 ← Torque (N-m)

- Equation given in book:

$$\text{hp} = \frac{TN}{5252} \quad (\text{Eq. 3.13})$$

where hp = horsepower

T = torque, in pound-feet (lb ft)

N = speed, in revolutions per
minute (r/min)

Important!

SI Units vs. US Customary Units:

- Be able to convert between units of measure.
 - For tests: Do not need to know conversion factors
 - For future work: Be familiar with conversion factors.
 - E.g. 1 hp \approx 750 Watts
- Know the SI-based equations:
 - These are more fundamental
 - For tests: Need to know these equations.
 - E.g. $P = \tau \omega$
 - For future work: Understand these equations.

Electrical Test Equipment

- Example test equipment
 - Digital Multimeters (DMMs)
 - Voltage Testers
 - Reduced operation from DMM
 - Current Testers
 - Clamp-on Ammeters
 - Megohmmeter
 - Measure large resistances (e.g. insulation)
 - Power Analyzer
 - Measure real and reactive power
 - Oscilloscope
 - Mostly test-bench
 - Most informative

Digital Multimeter

- Generally can measure
 - AC and DC voltage
 - AC and DC current
 - Resistance
 - Connectivity
- Important for Correct Usage:
 - Multiple terminals



Voltage Testers

Non-contact

- Find live circuits
- Generally for safety



Contact

- Reduced Operation from DMM
- Generally measure AC and DC voltages
- Ballpark measurements!



Ammeters

- Contact Meters
 - Like the function on the DMM
 - Not as useful in the field
- Non-contact Meters (Clamp-On)
 - No need to break circuit
 - Senses current by induction
 - Measures TOTAL current



Megohmmeter

- Measures very large resistances
 - Into the $G \Omega$ range
 - Requires large voltage source 500 to 1000 V
 - Useful for testing insulations



Oscilloscope

- Allows “view” of electrical signals
- Gives most information
- See demonstration