

# TAMU (Power) Program

- 9 faculty members (5 systems, 4 power electronics)
- 6 undergraduate, 14 graduate courses
- Undergraduate has to elect at least 5 senior level ECE courses in 3 areas, more than 2 in at least one specialized area
- We have 9 focus areas in the graduate program and 6 focus areas in undergraduate program
- 78 faculty members in ECE dept.
- 1400 undergraduate students, 500 graduate students.(350 PhD, 150 MS)

Load Characteristics/Power Quality  
Discussion  
ONR/EPRI/AEP Corvallis OR Faculty  
Workshop

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# Utility Load Distribution

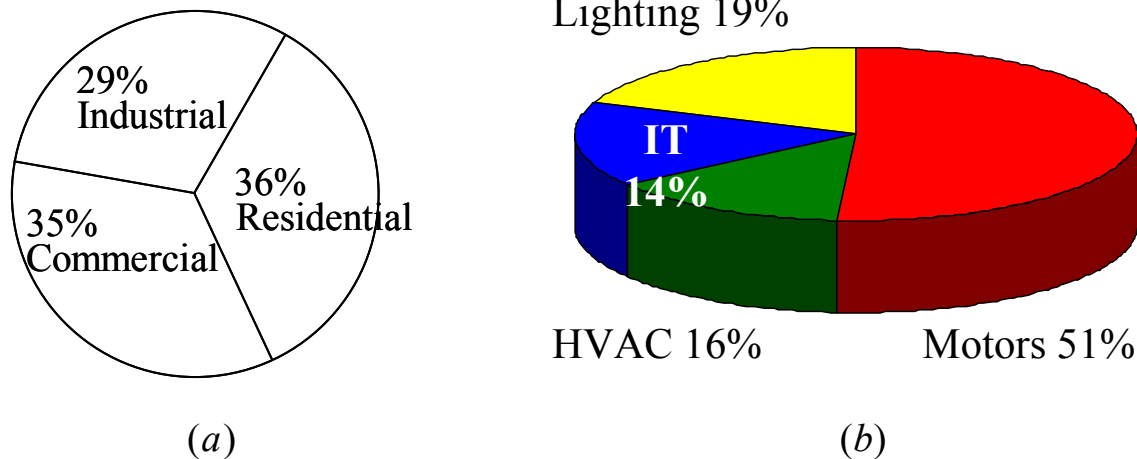


Fig. 8-3 Utility loads.

- Reminder: 25% of total energy consumption is car energy consumption for power energy to cover
- Reminder: The above is about 60% of current power consumption

# Power Factor and Voltage Sensitivity of Power Systems Load

Table 8-1 Power Factor and Voltage Sensitivity of Power Systems Load

Type of Load	Power Factor	$a = \partial P / \partial V$	$b = \partial Q / \partial V$
Electric Heating	1.0	2.0	0
Incandescent Lighting	1.0	1.5	0
Fluorescent Lighting	0.9	1.0	1.0
Motor Loads	0.8 – 0.9	0.05 – 0.5	1.0 – 3.0
Modern Power-Electronics based Loads	1.0	0	0

# Power Quality Issues

- Interruption of power supply
- Voltage flickering & collapsing
- Frequency deviations
- Harmonics
- Power factors
- Key questions:
  - What are the side effects? Why does it matter?
    - Loss of loads
    - Real power losses, heats
    - Shorten equipment life/Damage equipments
    - Performance degrading
    - Impacts on analysis and design

# Torque-Speed Characteristics

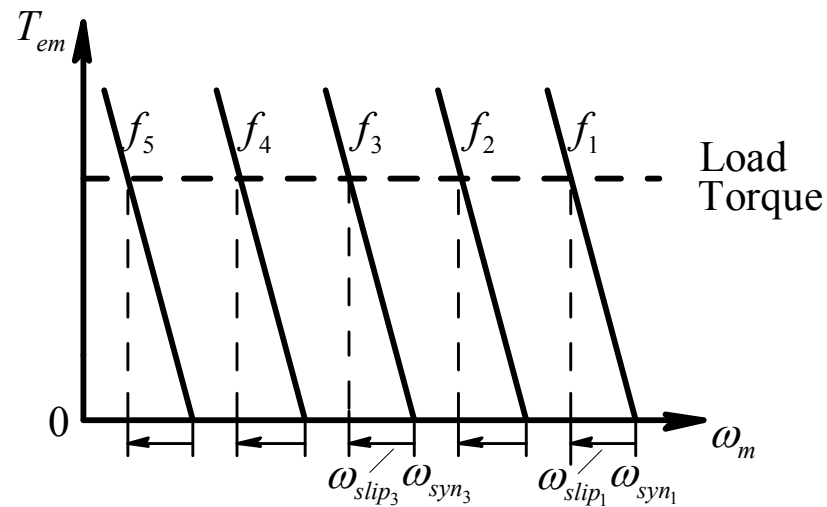


Fig. 8-6 Torque-speed characteristic of induction motor at various applied frequencies.

# Uninterruptible Power Supplies (UPS)

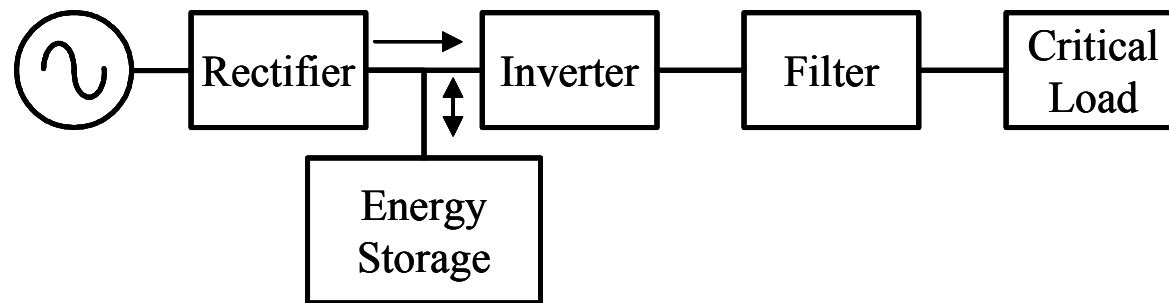


Fig. 8-8 Uninterruptible power supply.

# Static Power-Transfer Switch

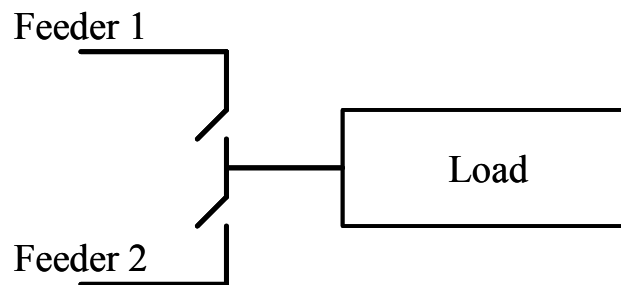


Fig. 8-9 Alternate feeder.



# CBEMA Curve Showing Acceptable Voltage-Time Region

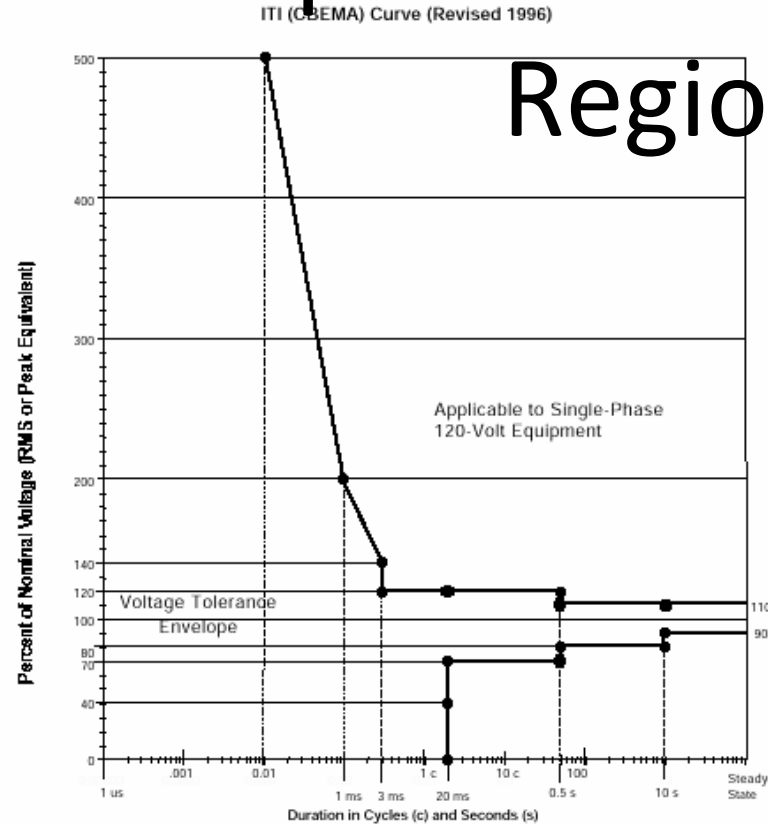


Fig. 8-10 CBEMA curve.

# Dynamic Voltage Restorers (DVR)

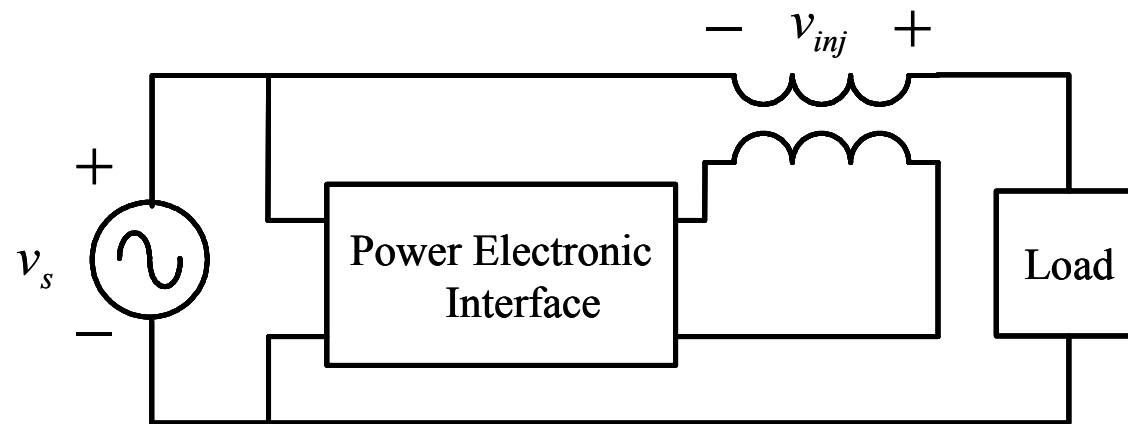


Fig. 8-11 Dynamic Voltage Restorer (DVR).

# Voltage Regulating Transformers



Fig. 8-12 Three-Phase Voltage Regulator (Courtesy of Siemens) [5].

# Influence of Distortion on Power Factor

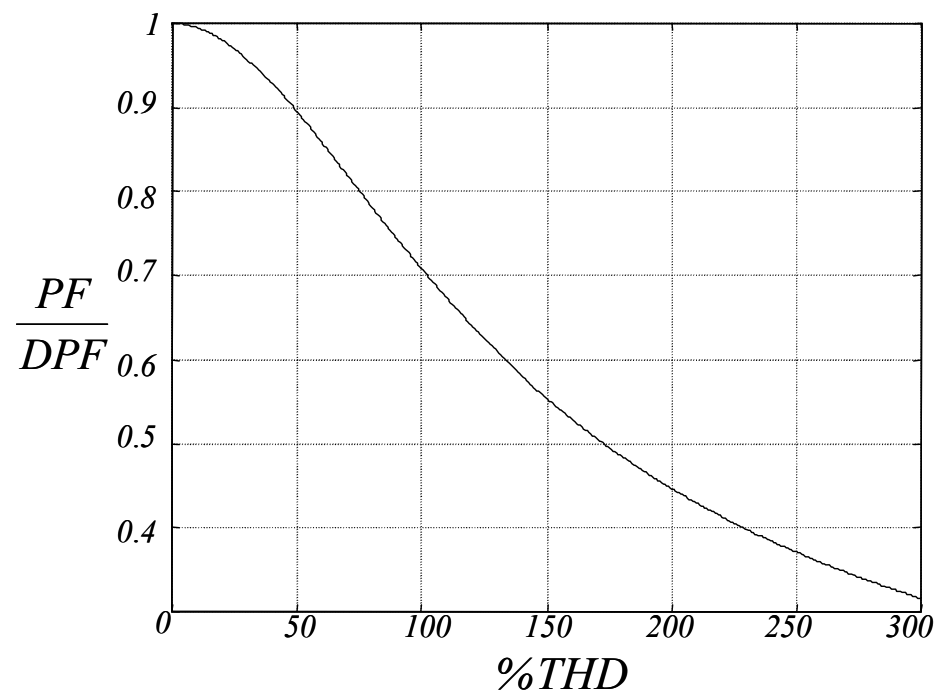


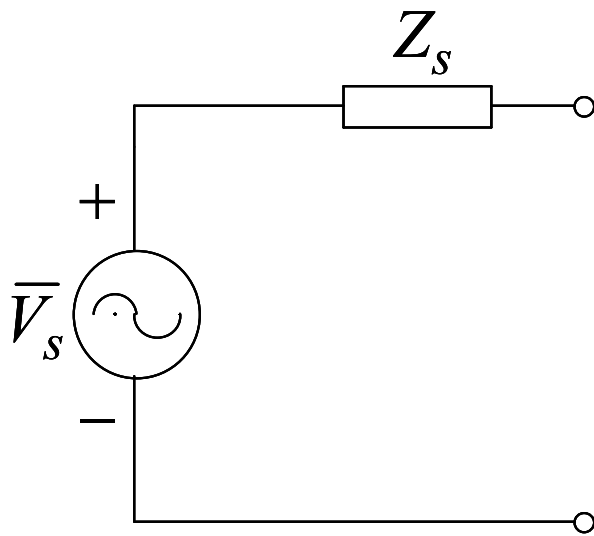
Fig. 8-17 Relation between PF/DPF and THD.

# IEEE Harmonic Limits

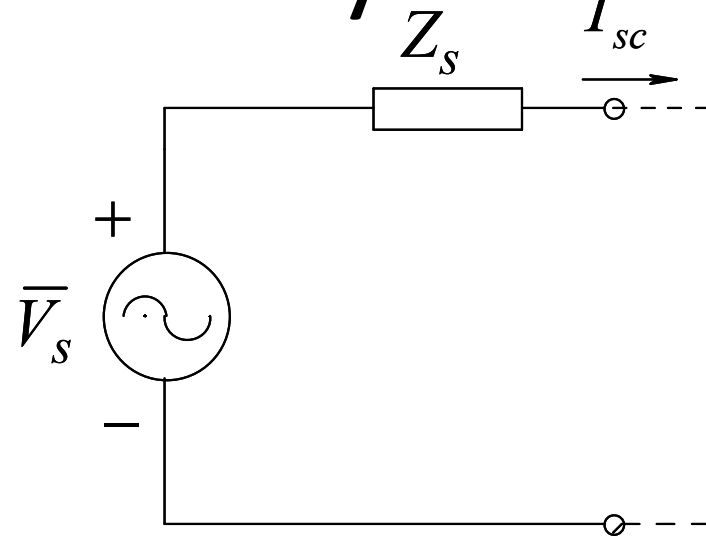
Table 8-1 Harmonic current distortion ( $I_h / I_1$ )

$I_{sc} / I_1$	<i>Odd Harmonic Order <math>h</math> (in %)</i>					<i>Total Harmonic Distortion(%)</i>
	$h < 11$	$11 \leq h < 17$	$17 \leq h < 23$	$23 \leq h < 35$	$35 \leq h$	
$< 20$	4.0	2.0	1.5	0.6	0.3	5.0
20 – 50	7.0	3.5	2.5	1.0	0.5	8.0
50 – 100	10.0	4.5	4.0	1.5	0.7	12.0
100 – 1000	12.0	5.5	5.0	2.0	1.0	15.0
$> 1000$	15.0	7.0	6.0	2.5	1.4	20.0

# Short-Circuit Current for worst case realy studies



(a)



(b)

Figure 8-18 (a) Utility Supply, (b) Short-Circuit Current.

# Labs

- To show the effect of imbalance
- To show the effect of second and third harmonics
- To show the effects of power factors
- We have a separate power quality course

# Questions???

- ???