

Lecture # 3

ECEN 438/738 Power Electronics

Spring 2025 Semester



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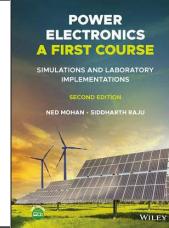
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ECEN 438/738 Power Electronics

Power Electronics A First Course: 2nd Edition

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Chapter 1
Power Electronics: An Enabling Technology

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BOOK
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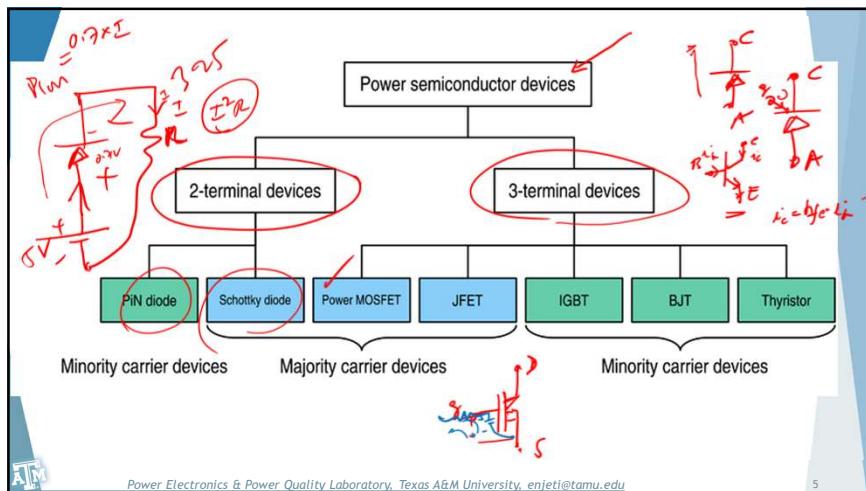
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Power semiconductor devices are the heart of power electronics

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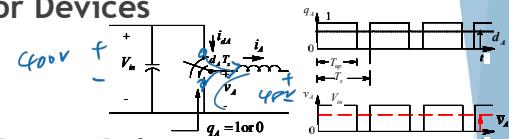
Design of Switching Power-Poles

► Power Semiconductor Devices

- Diodes
- Transistors

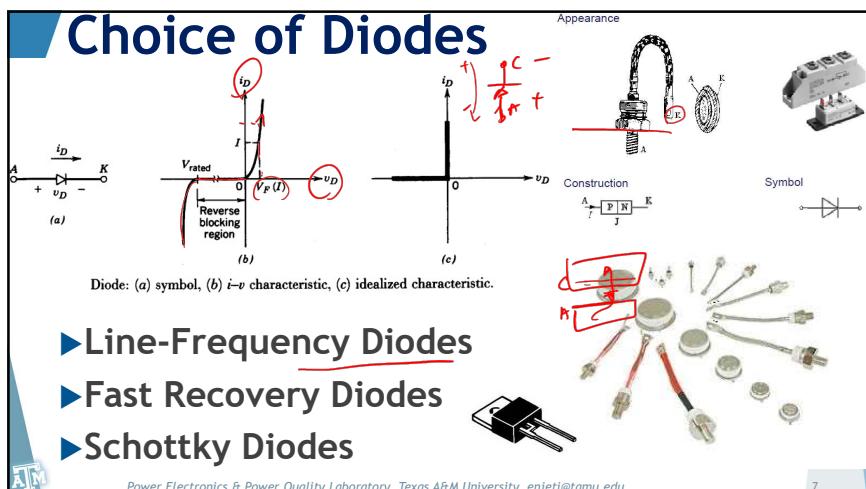
► Losses in Switching Power-Poles

- Switching Losses
- Conduction Losses

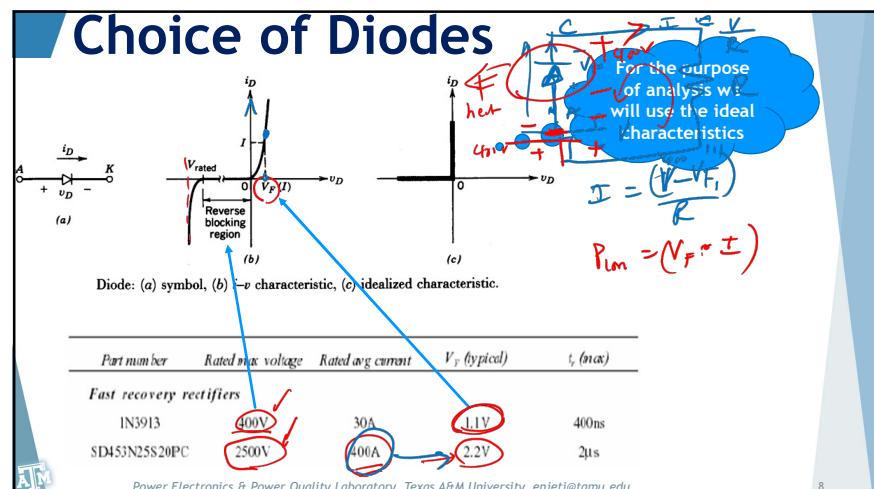


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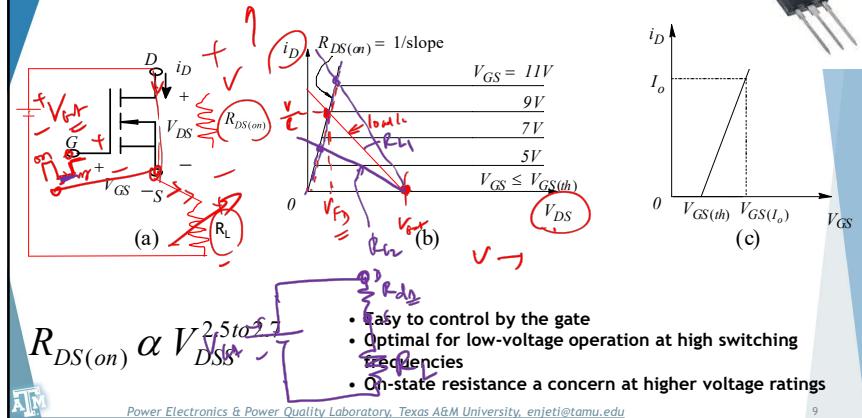


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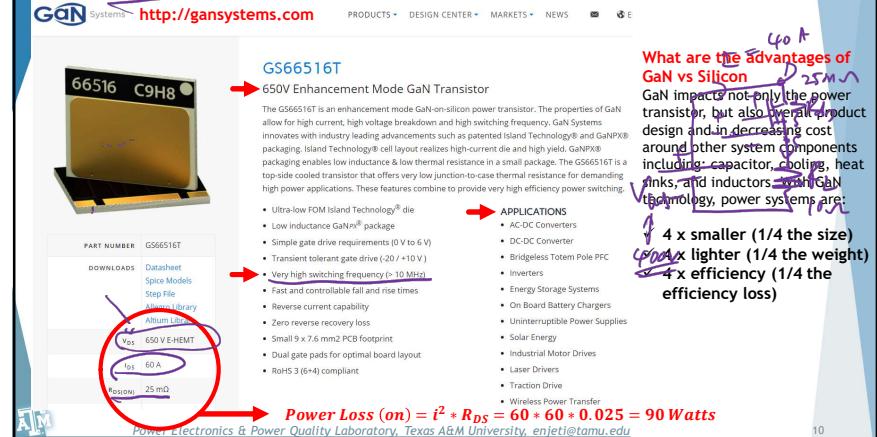
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Power MOSFET Characteristics



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GaN MOSFET Characteristics



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Silicon Carbide (SiC) MOSFET

1700V Silicon Carbide MOSFETs

Faster switching and enhanced reliability for next-generation power conversion

TRY OUR SPEEDFIT 2.0 DESIGN SIMULATOR

Wolfspeed 1700V SiC MOSFETs enable smaller and more efficient power conversion systems. Compared to silicon-based solutions, Wolfspeed silicon carbide technology enables increased system power density, higher switching frequencies, smaller designs, cooler components, reduced size of components like inductors, capacitors, filters & transformers, and overall cost benefits.

Product SKU | Buy Online | Data Sheet | Blocking Voltage | Reverse $V_{DS(on)}$ @ 25°C | Generation | Current Rating | Gate Charge Total | Output Capacitance | Total Power Dissipation (Pdiss) | Maximum Junction Temperature | Package | Recommended For New Design?

C2M1000170D			1700 V	1000 mΩ	Gen 2	8.5 A	13 nC	12 pF	69 W	150 °C	TO-247-4	Yes
C2M0080170P			1700 V	80 mΩ	Gen 2	40 A	120 nC	105 pF	277 W	150 °C	TO-247-4	Yes
C2M1000170J			1700 V	1000 mΩ	Gen 2	5.3 A	13 nC	12 pF	78 W	150 °C	TO-257-7	Yes
C2M0045170D			1700 V	45 mΩ	Gen 2	72 A	188 nC	171 pF	520 W	150 °C	TO-247-4	Yes
C2M0045170P			1700 V	45 mΩ	Gen 2	72 A	188 nC	171 pF	520 W	150 °C	TO-247-4	Yes

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Silicon Carbide (SiC) MOSFET

CREE

E3M0065090D

Silicon Carbide Power MOSFET
E-Series Automotive
Enhancement Mode

Features

- 3rd generation SiC MOSFET
- High blocking voltage with low On-resistance
- Fast switching speed with low reverse recovery (Dr)
- Automotive Qualified (AEC-Q101) and I/P/P Capable

Benefits

- Higher system efficiency
- Reduced cooling requirements
- Smaller footprint
- Increased system switching frequency

Applications

- Renewable energy
- Industrial power
- High-voltage DC/DC converters
- Delta Mode Power Supplies

Electrical Characteristics ($T_j = 25^\circ\text{C}$ unless otherwise specified)

Symbol

Parameter

Min.

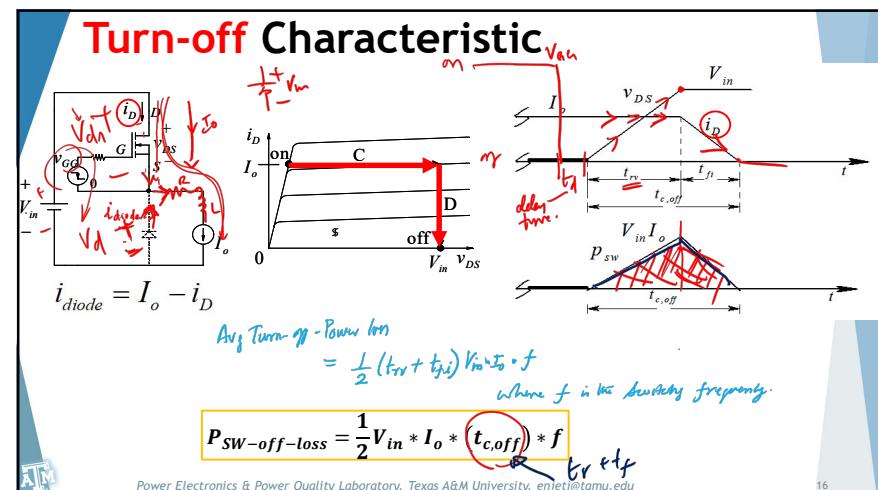
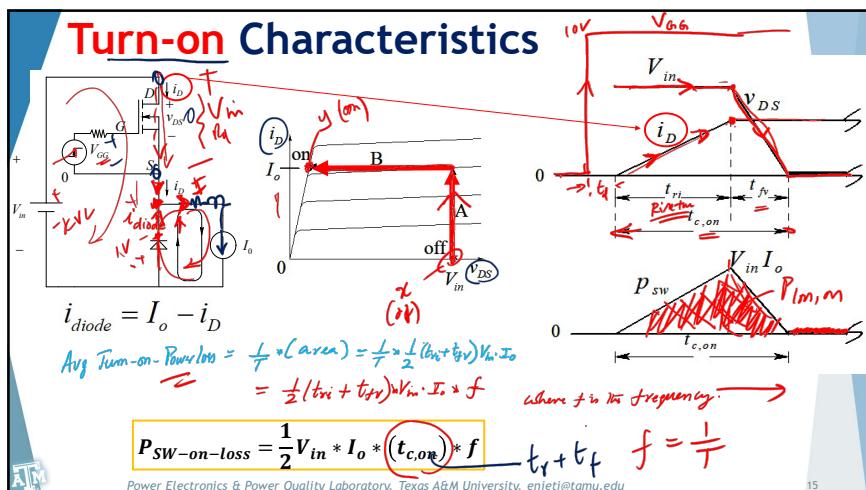
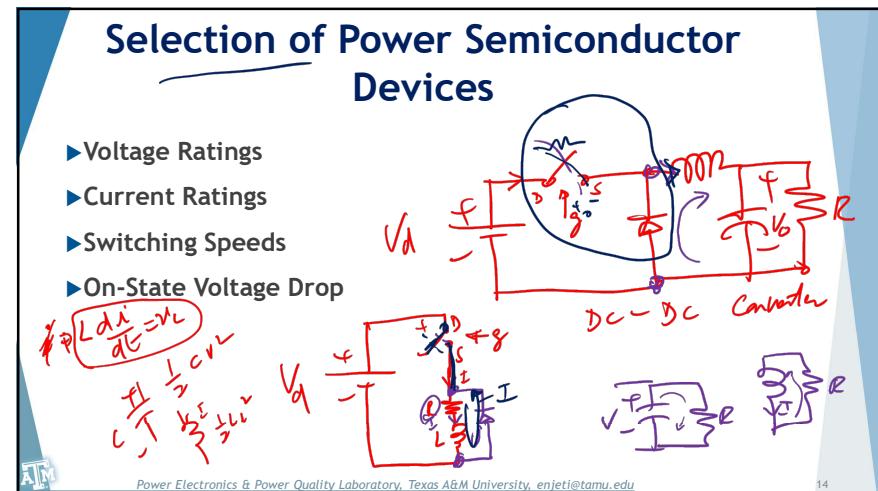
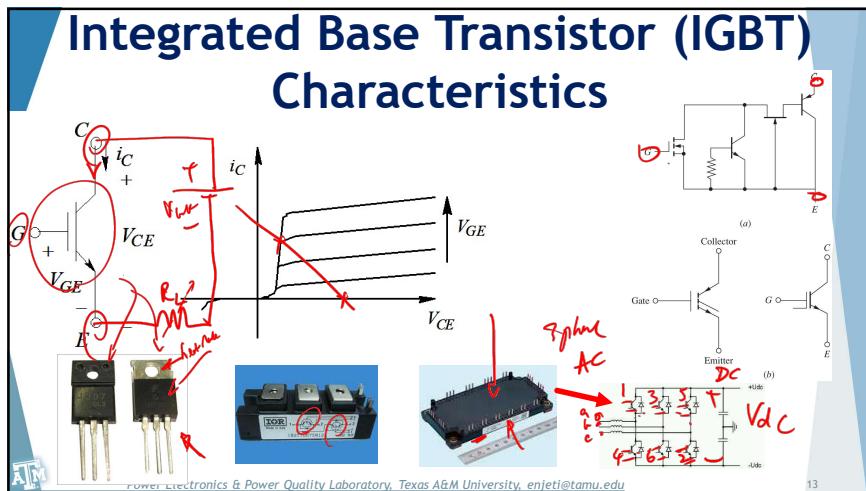
Typ.

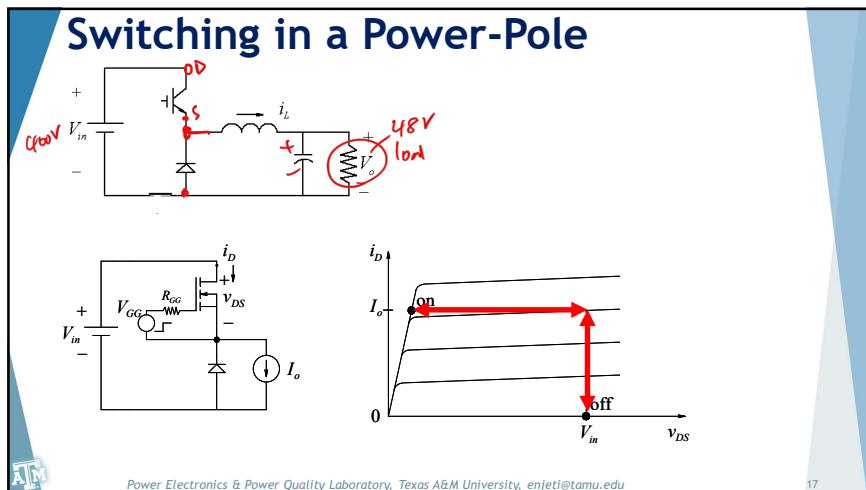
Max.

Unit

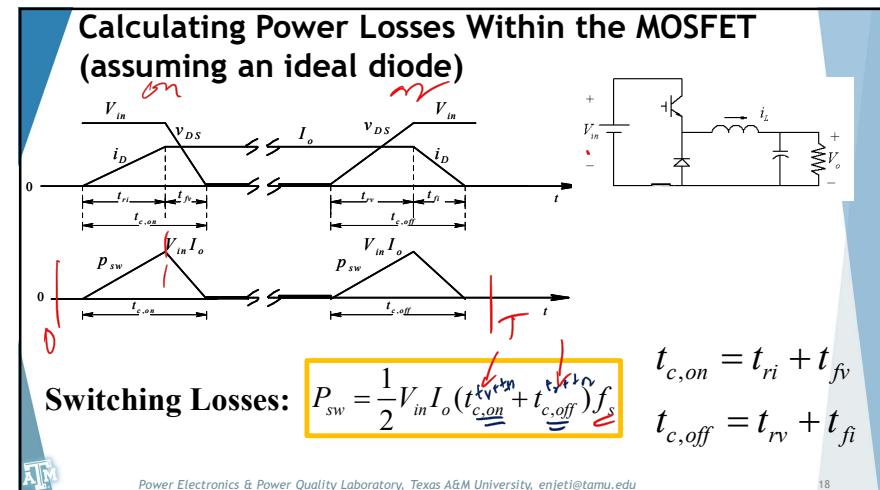
Test Conditions

Note

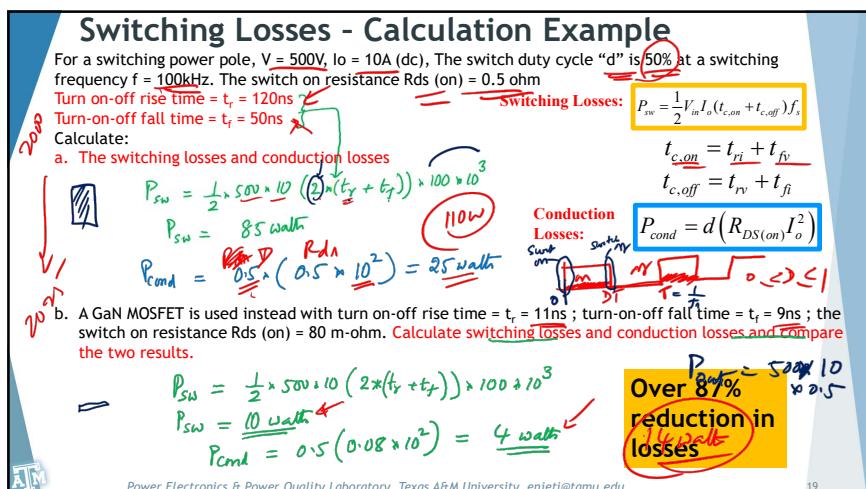




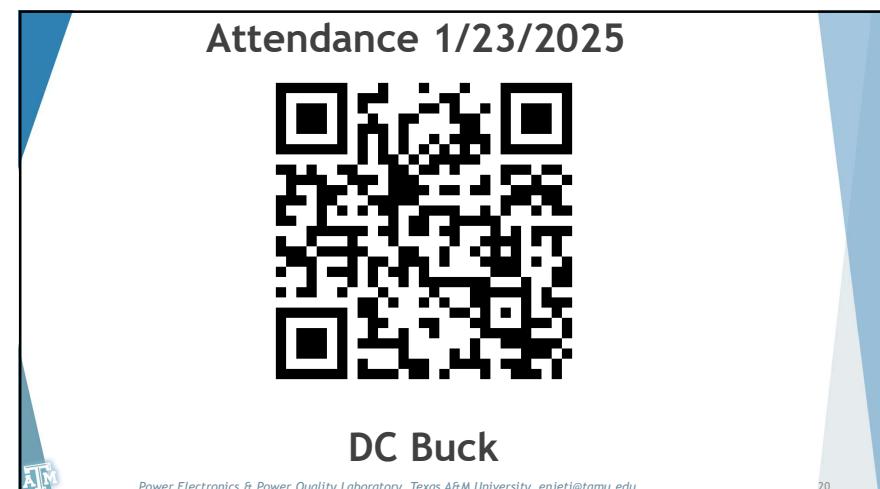
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DC - DC Converters

<https://www.marketsandmarkets.com/Market-Reports/global-dc-dc-converter-market-17565254.html>

- Applications
- Classifications
- Applications in AC Synthesis
- Basic Concepts in DC Steady State

9.9 USD Billion \$ Market - projected to grow to 17.6 USD Billion by 2026

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DC - DC Converters

DC-DC Converter Market By Input Voltage (5-36V, 36-75V, 75V and Above), Output Voltage (3.3V, 5V, 12V, 15V and Above), Mounting Style (Surface Mount and Through Hole), Application (Smartphone, Servers & Storage, EV Battery Management Unit, Railway, and Medical Equipment): Global Opportunity Analysis and Industry Forecast, 2020-2027

SE : Electronic Systems and Devices A05304 Pages: 289 Oct 2020 | 5294 Views f t in

Author(s) : Avinash Saverkar, Vineet Kumar Tables: 130 Charts: 77 Formats*: PDF, EPUB, MOBI

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COVID-19

Pandemic disrupted the entire world and affected many industries.

Get detailed COVID-19 impact analysis on the Dc-dc Converter Market

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DC-DC Converter Market Outlook - 2027

The global DC-DC Converter market size was valued at \$8.76 billion in 2019, and is projected to reach \$17.85 billion by 2027, growing at a CAGR of 11.10% from 2020 to 2027. DC-DC converters are high-frequency power conversion circuits that use high-frequency switching and inductors, transformers, and capacitors to smooth out switching noise into regulated DC voltages. DC-to-DC converters are used to reduce High voltage DC input to low voltage DC output for some specific applications. They are also used to isolate some highly sensitive components in a circuit from other components to avoid any kind of damage.

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A simple dc-dc converter example

Input source: 100V
Output load: 50V, 10A, 500W
How can this converter be realized?

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Linear Regulator

Dissipative realization

Resistive voltage divider

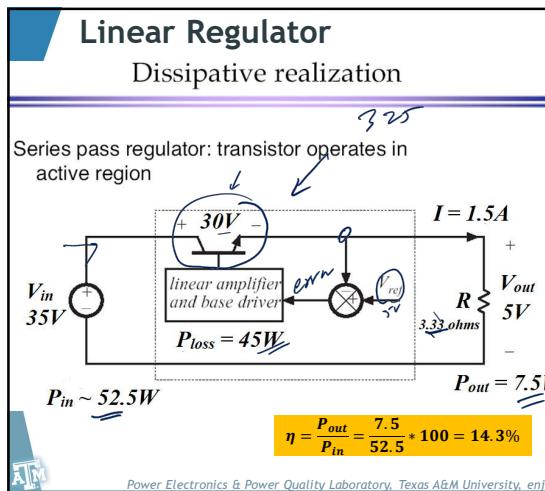
Quiz # If the required output voltage is 10V and the current is I = 10A, calculate the efficiency.

$P_{in} = 1000W$ $P_{loss} = 500W$ $I = 10A$ $V = 50V$ $P_{out} = 500W$

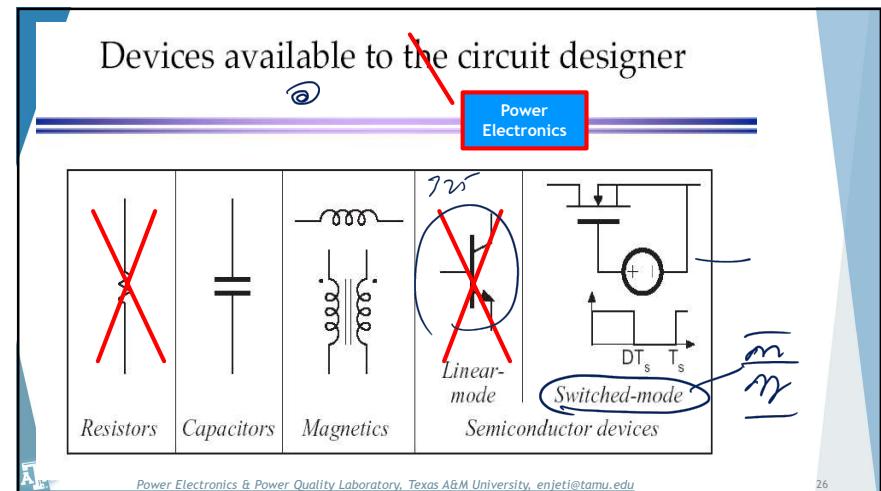
Efficiency = $P_{out}/(P_{out} + P_{loss}) = 500/1000 = 50\%$

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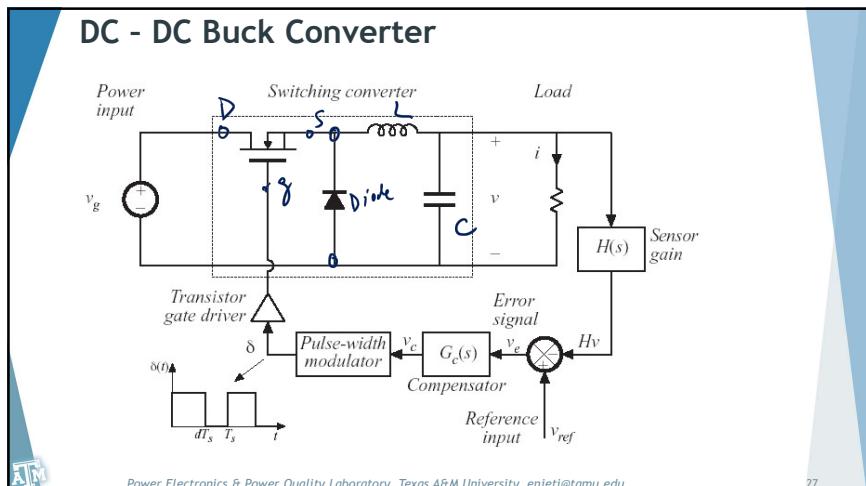
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