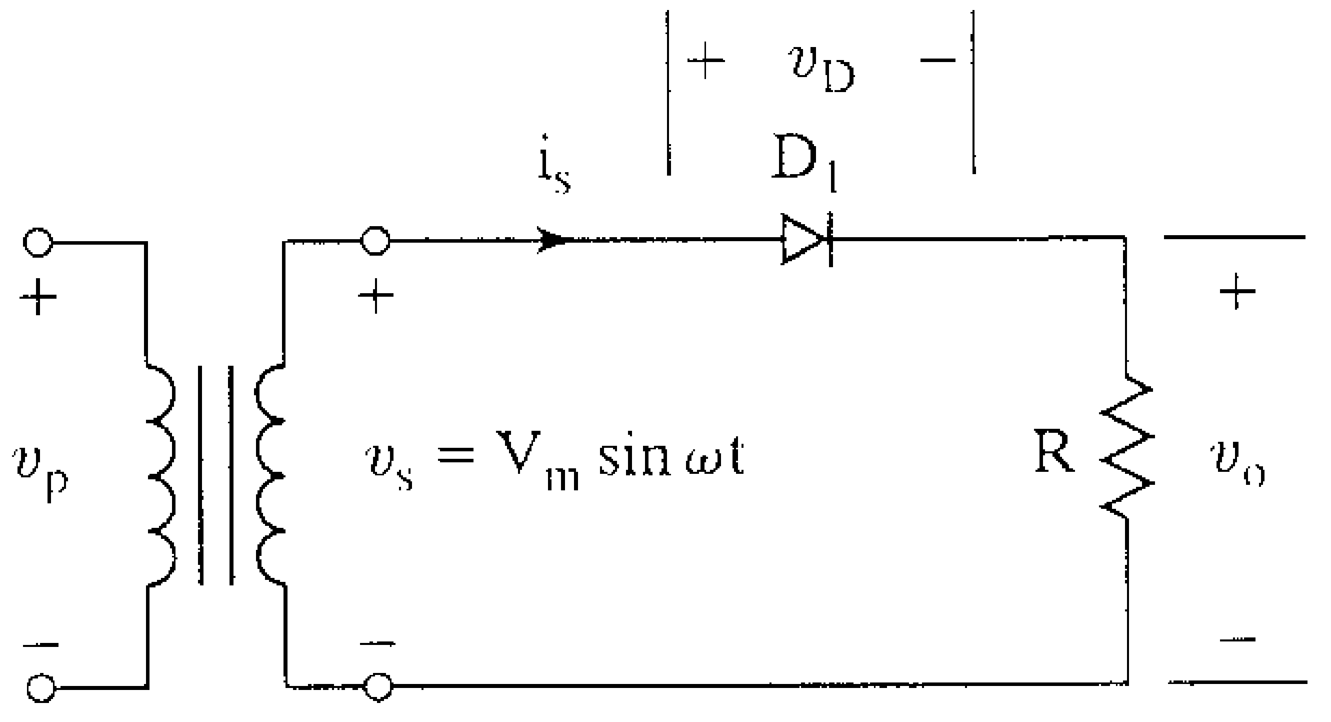
Rectification

Muhammad Hafeez Javed

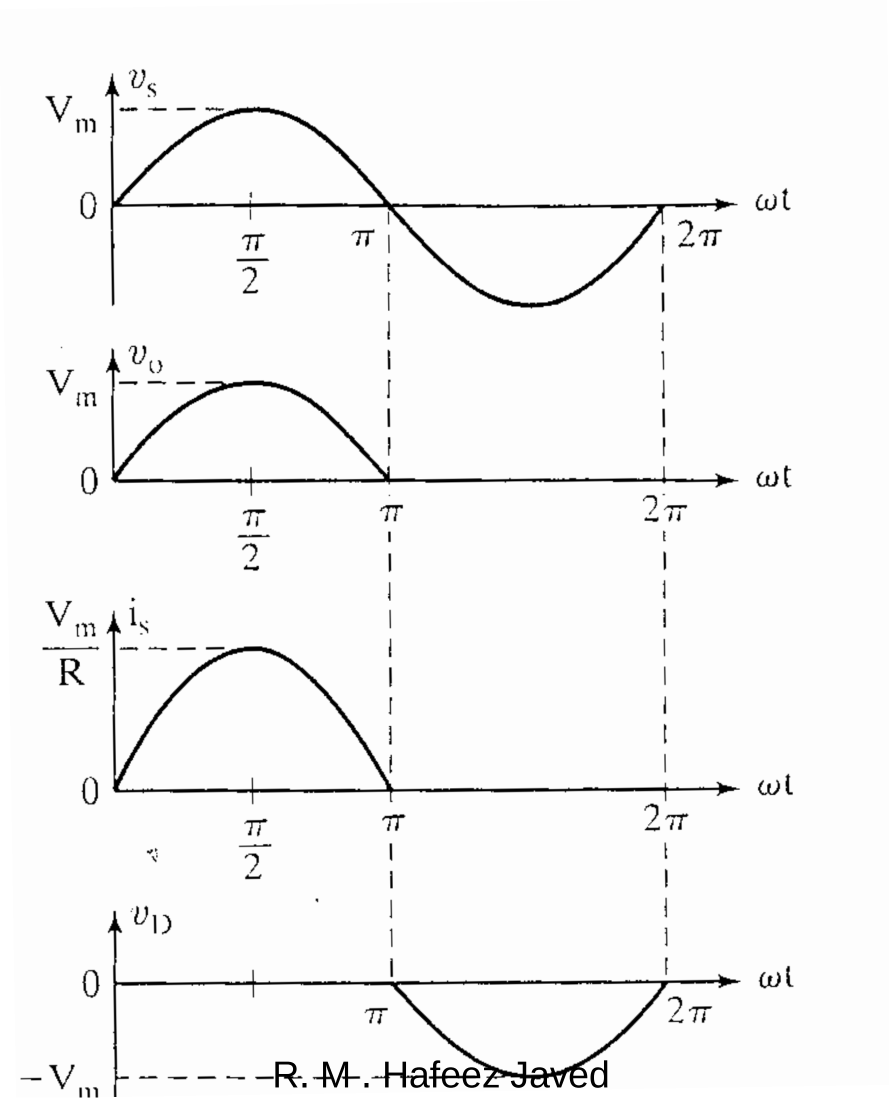
rmhjaved@gmail.com

www.Rmhjaved.com

Single-Phase Half-Wave Rectifier

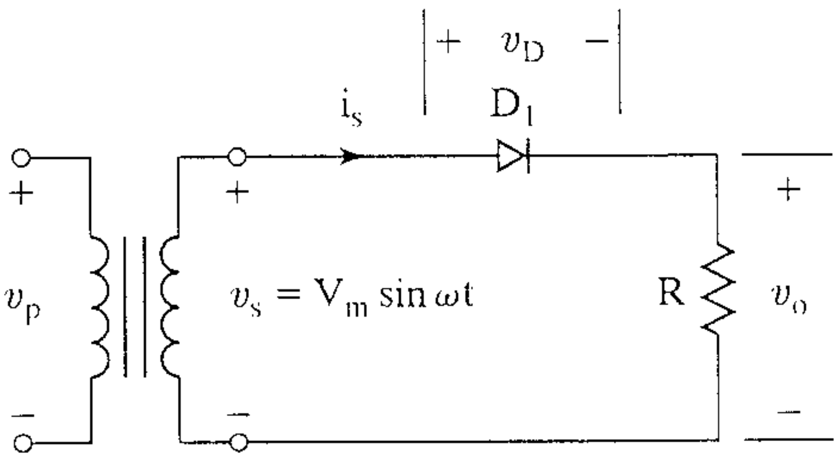


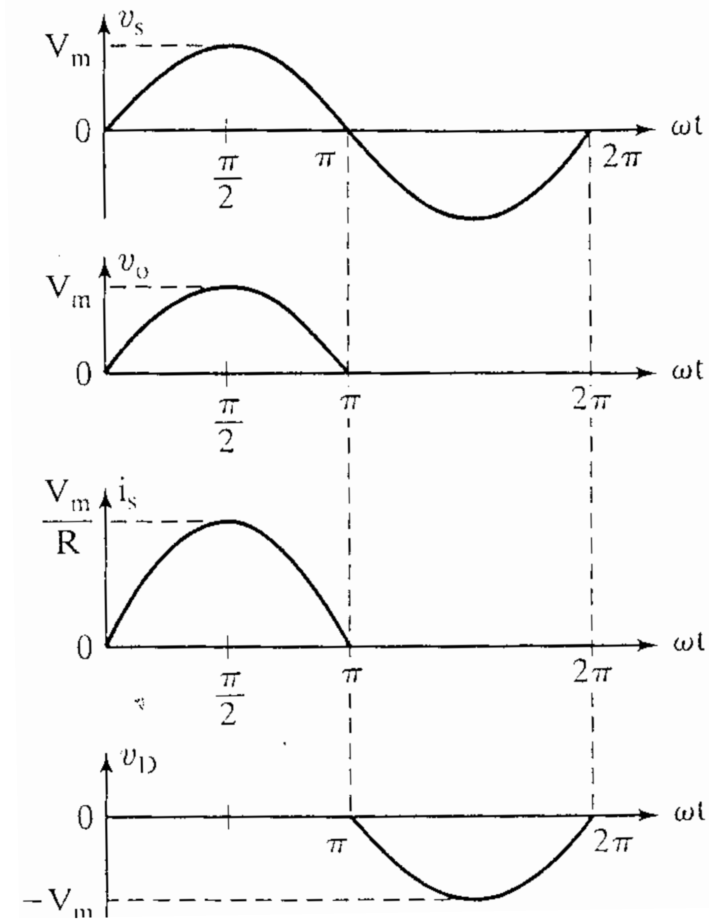
Waveforms



v_s
V_m
0
ωt
$\frac{\pi}{2}$
π
2π
v_o
V_m
0
ωt
$\frac{\pi}{2}$
π
2π
$\frac{V_m}{R}$
i_s
0
ωt
$\frac{\pi}{2}$
π
2π
v_D
0
ωt
π
2π
$-V_m$

Single-Phase Half-Wave Rectifier



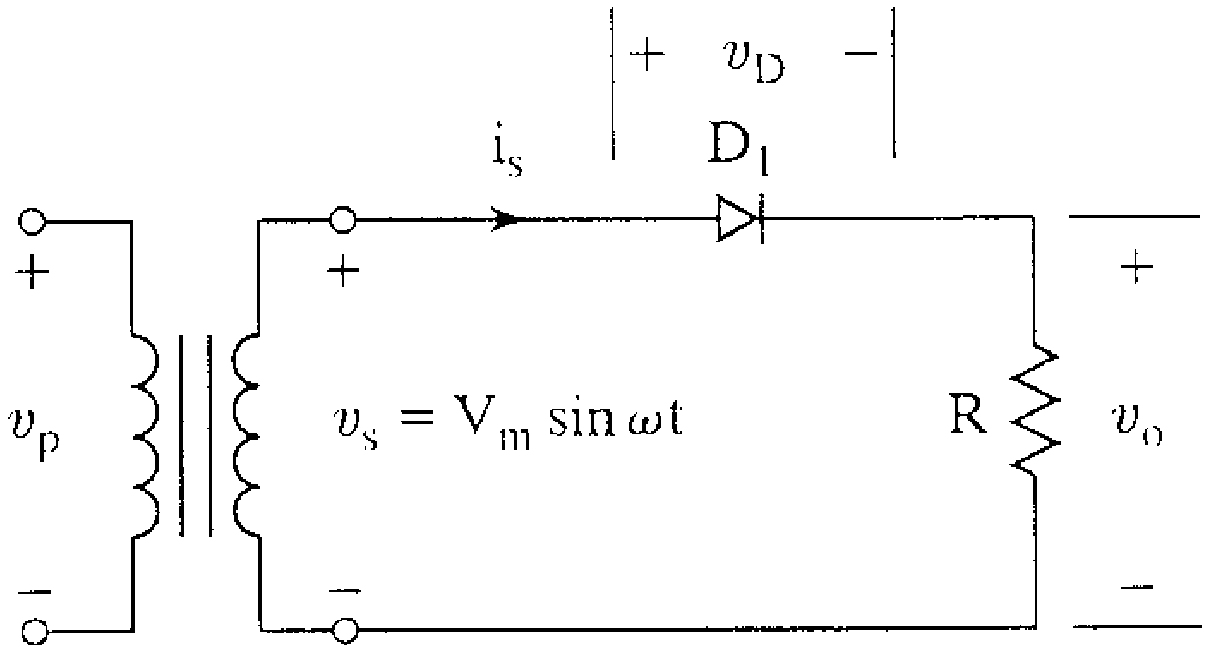


Performance Parameters

- Average value of the output voltage, V_{dc}
- Average value of the output current, I_{dc}
- Output dc power, P_{dc}
  - $P_{dc} = V_{dc} I_{dc}$
- rms value of the output voltage, V_{rms}
- Output ac power, P_{ac}
  - $P_{ac} = V_{rms} I_{rms}$

Example 3.1

- Determine V_{dc} and I_{dc}

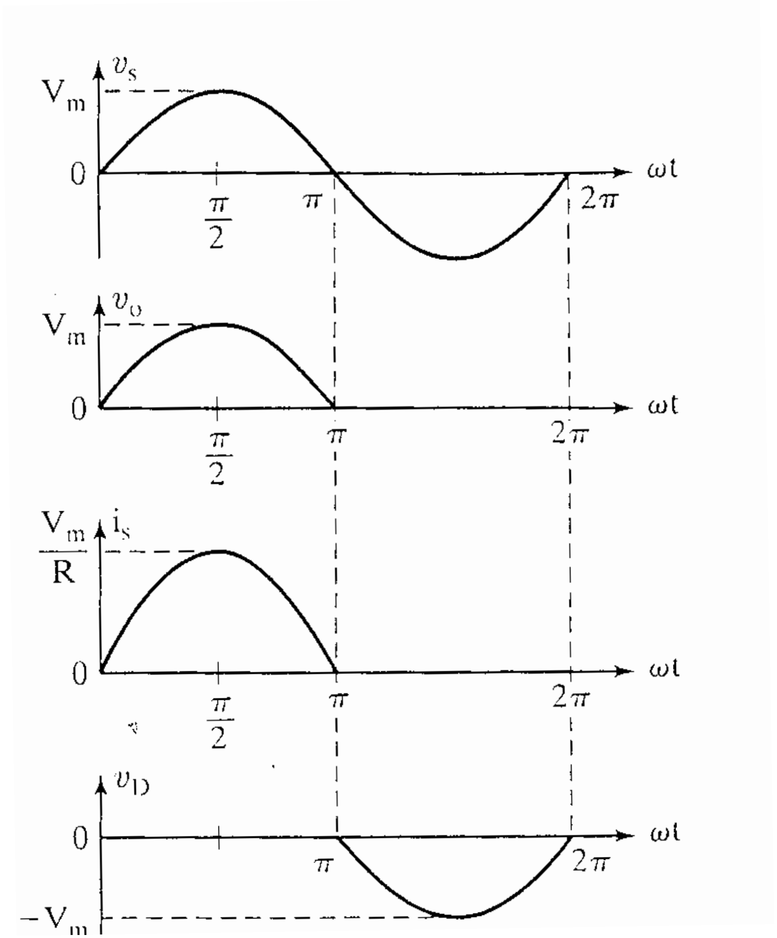


Determine the Average Voltage, V_{dc}

$$V_{dc} = \frac{1}{T}\int_0^T v_L(t)dt$$

$$V_{dc} = \frac{1}{T}\int_0^{\frac{T}{2}} V_m \sin \omega t dt$$

$$V_{dc} = -\frac{V_m}{\omega T}(\cos\frac{\omega T}{2} - 1)$$



$$f = \frac{1}{T}$$

$$\omega = 2\pi f$$

$$V_{dc} = \frac{V_m}{\pi} = 0.318 V_m$$

$$I_{dc} = \frac{V_{dc}}{R} = \frac{0.318 V_m}{R}$$

FULL WAVE RECTIFIER

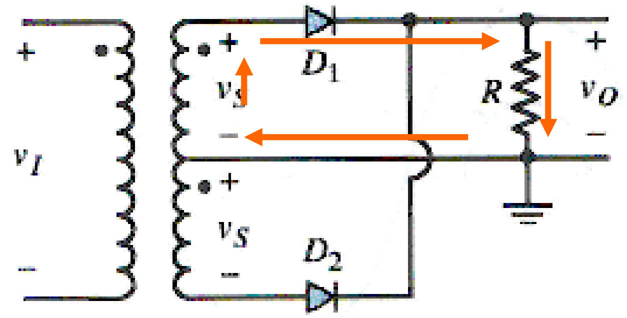
- Center-Tapped
- Bridge

Full-Wave Rectification – circuit with center-tapped transformer

- *Positive cycle*, D2 off, D1 conducts;

  $V_o - V_s + V_\gamma = 0$

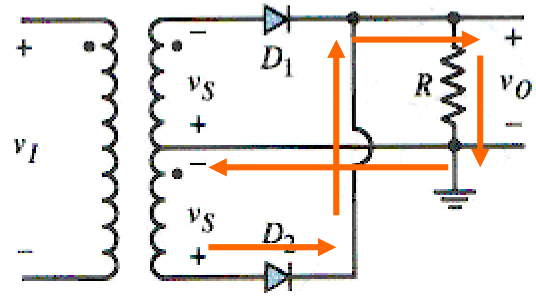
  $V_o = V_s - V_\gamma$



- *Negative cycle*, D1 off, D2 conducts;

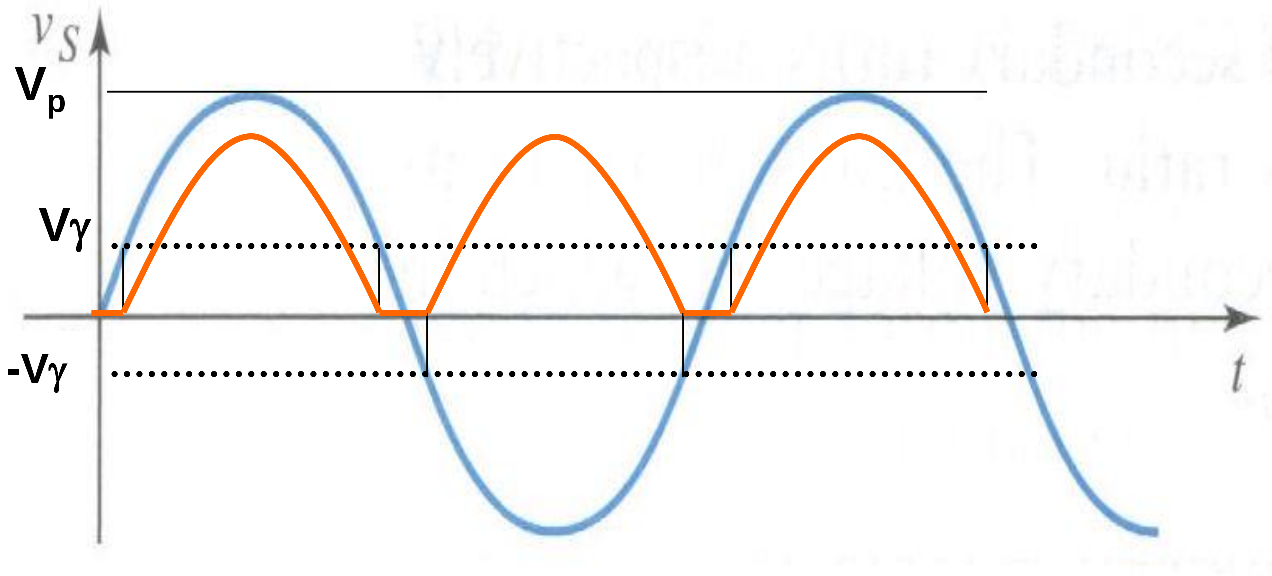
  $V_o - V_s + V_\gamma = 0$

  $V_o = V_s - V_\gamma$



- Since a rectified output voltage occurs during both positive and negative cycles of the input signal, this circuit is called a **full-wave rectifier**.
- Also notice that the **polarity of the output voltage for both cycles is the same**

$V_s = V_p \sin \omega t$

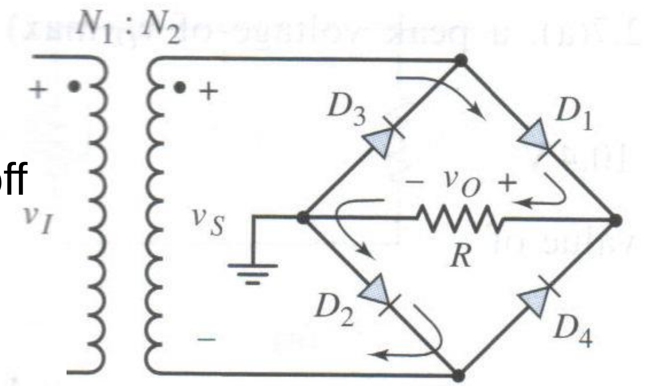


Notice again that the peak voltage of Vo is lower since **$V_o = V_s - V_\gamma$**

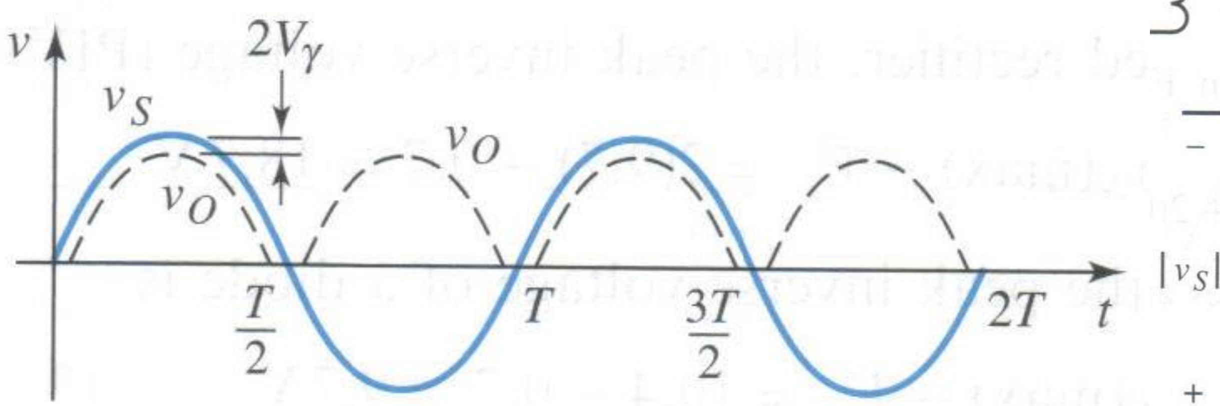
- **$V_s < V_\gamma$**, diode off, **open circuit**, no current flow, **<u>Vo = 0V</u>**

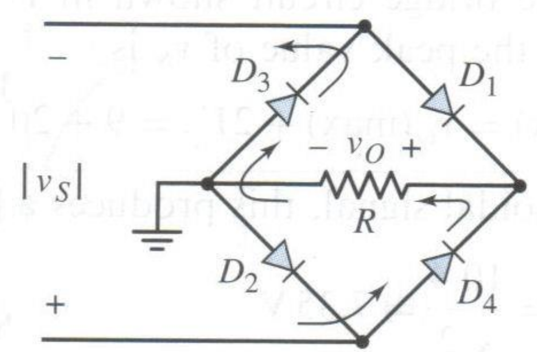
Full-Wave Rectification –Bridge Rectifier

- **Positive cycle**, D_1 and D_2 conducts, D_3 and D_4 off;
  $+ V\gamma + Vo + V\gamma – Vs = 0$
  Vo = Vs - 2Vγ



- **Negative cycle**, *D3* and *D4* conducts, *D1* and *D2* off
  $+ V\gamma + Vo + V\gamma – Vs = 0$
  Vo = Vs - 2Vγ

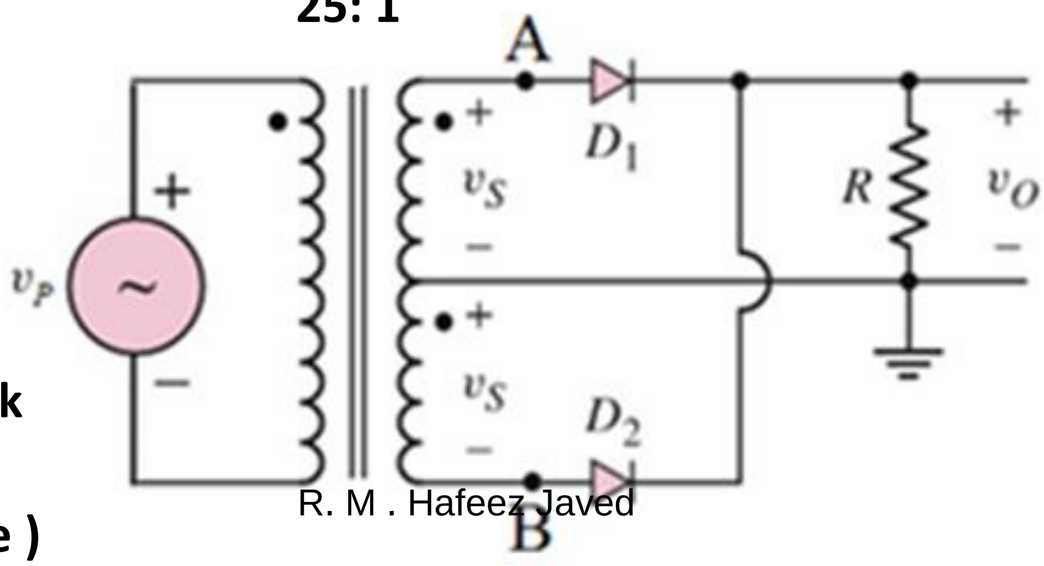




- Also notice that the **polarity of the output voltage for both cycles is the same**

- A full-wave center-tapped rectifier circuit is shown in Fig. 3.1. Assume that for each diode, the cut-in voltage, V_γ = 0.6V and the diode forward resistance, r_f is 15Ω. The load resistor, R = 95 Ω. Determine:
  - peak output voltage, V_o across the load, R
  - Sketch the output voltage, V_o and label its peak value.

25: 1



125 V (peak voltage) (sine wave)

- **SOLUTION**
- peak output voltage, V_o

$V_{s\ (peak)} = 125 / 25 = 5V$

$V_\gamma + I_D(15) + I_D\ (95) - V_{s(peak)} = 0$

$I_D = (5 - 0.6) / 110 = 0.04\ A$

$V_{o\ (peak)} = 95 \times 0.04 =$ **3.8V**