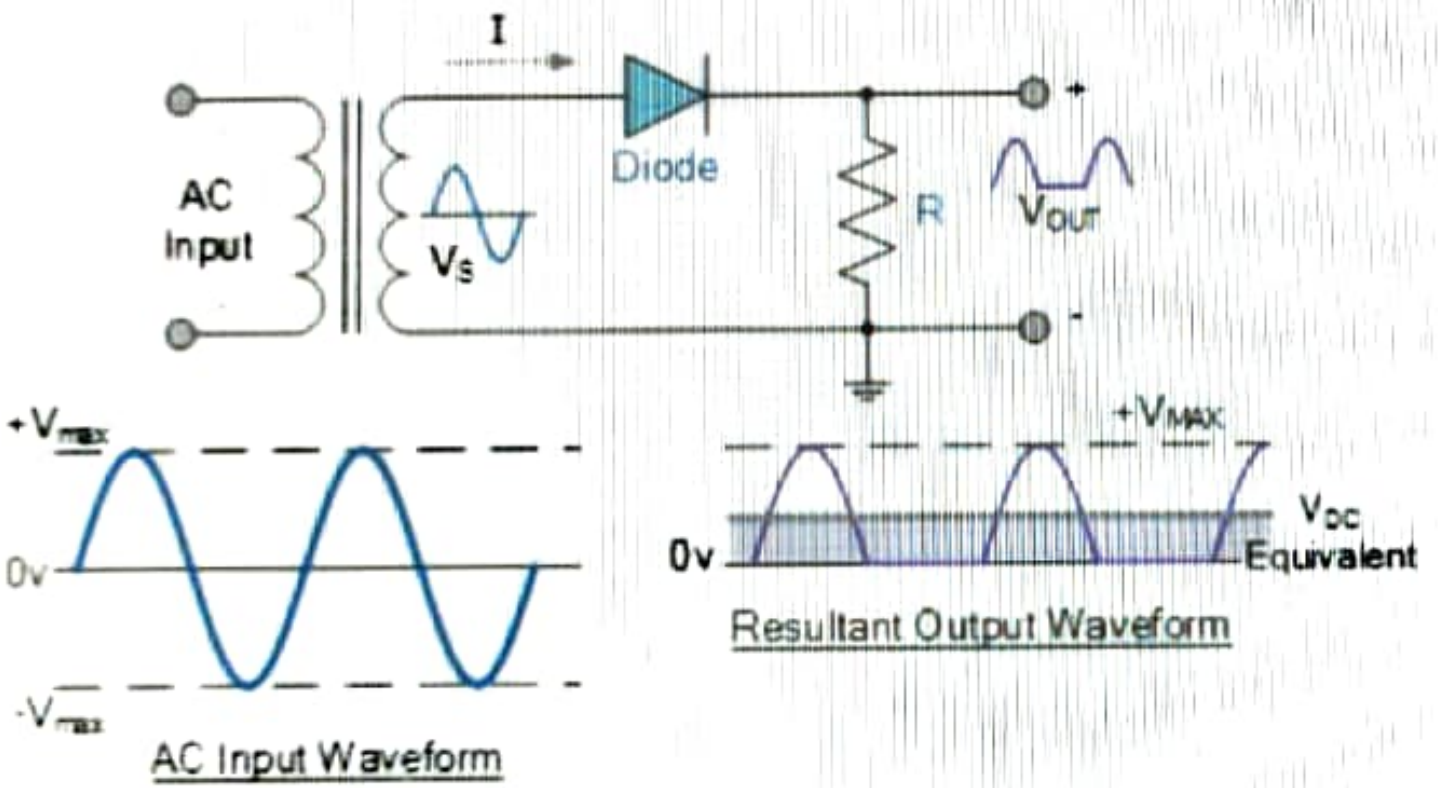
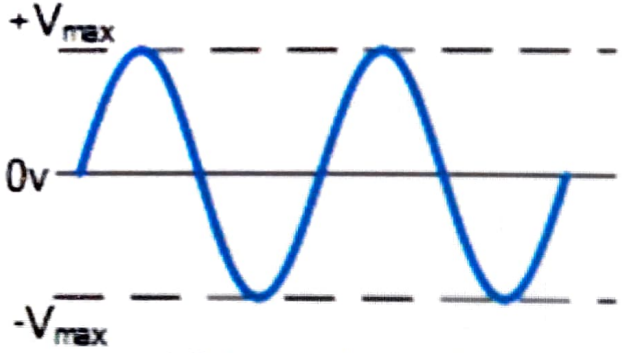
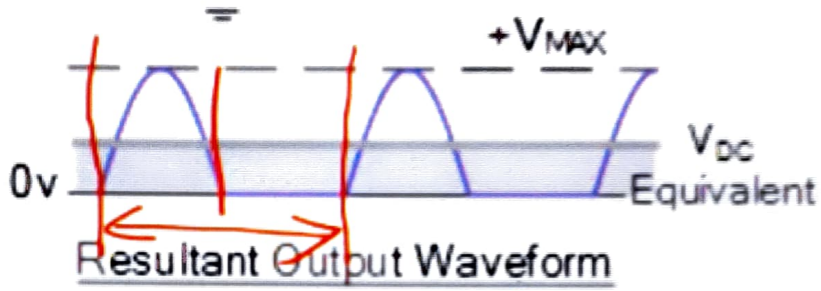
half-wave rectifier



half-wave rectifier



AC Input Waveform



Resultant Output Waveform

$T = 0.02\,S$

$f = 50\,Hz$

$T = \frac{1}{f} = 0.02\,S$

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$$V_{dc} = \frac{1}{2\pi}\left[\int_0^{\pi} v\,d\theta\right] = \frac{1}{2\pi}\left[\int_0^{\pi} (V_m \sin\theta)\,d\theta\right]$$

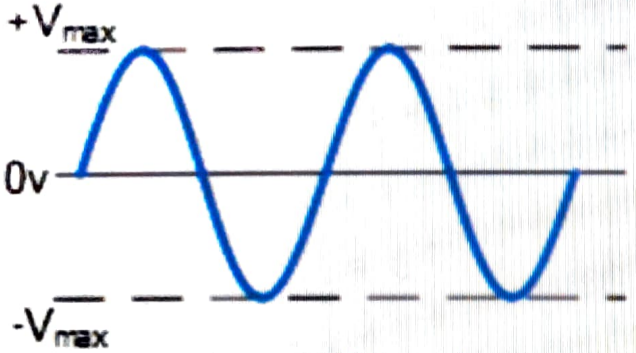
$$V_{dc} = \frac{V_m}{\pi}$$

$$V_{avg} = \frac{1}{T}\int_0^{\theta} v\,d\theta$$

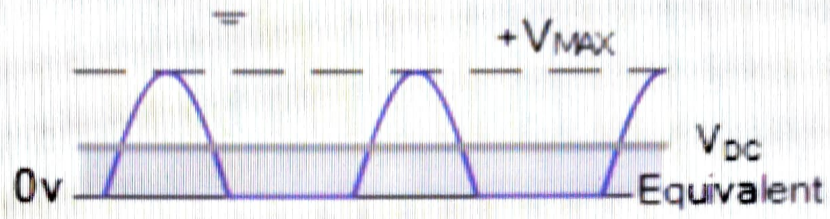
average → Integration ∫

slope → diff $= \frac{}{}$

half-wave rectifier



AC Input Waveform



Resultant Output Waveform

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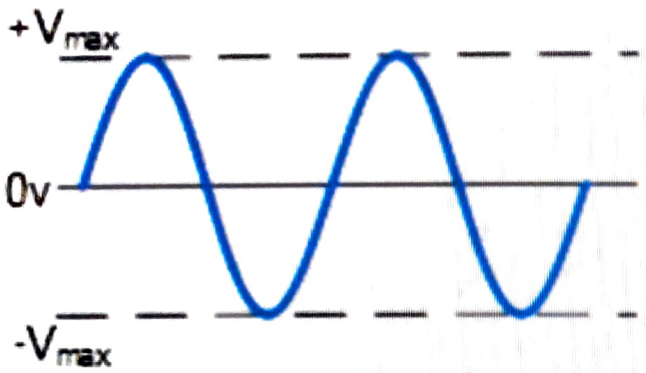
$$V_{rms} = \sqrt{\frac{1}{2\pi}\left[\int_0^{\pi} v^2 d\theta\right]} = \sqrt{\frac{1}{2\pi}\left[\int_0^{\pi} (V_m \sin\theta)^2 d\theta\right]}$$

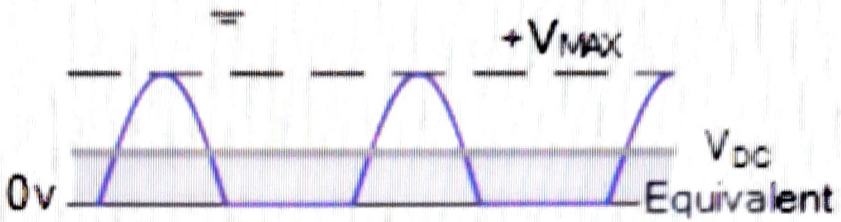
$$\sin^2\theta = \frac{1-\cos 2\theta}{2}$$

$$V_{rms} = \frac{V_m}{2}$$

half-wave rectifier



AC Input Waveform



Resultant Output Waveform

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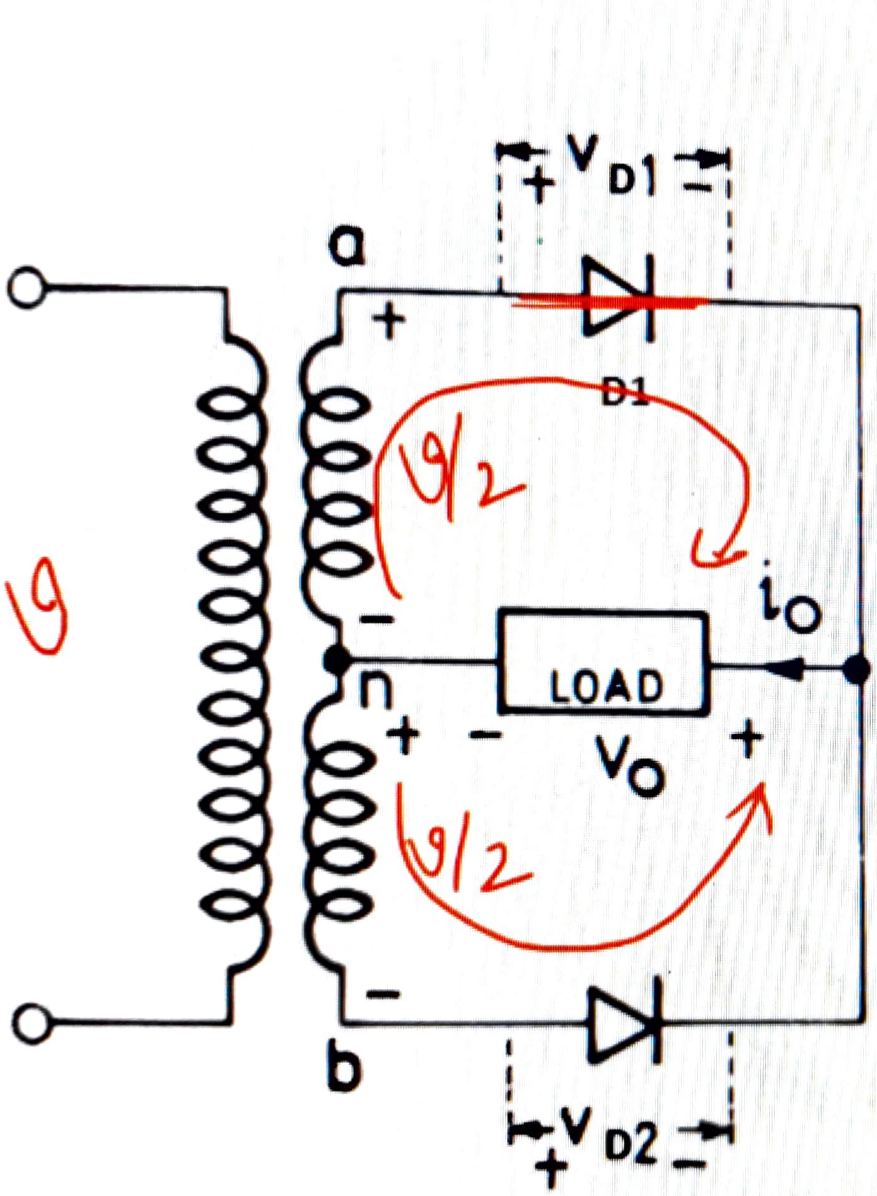
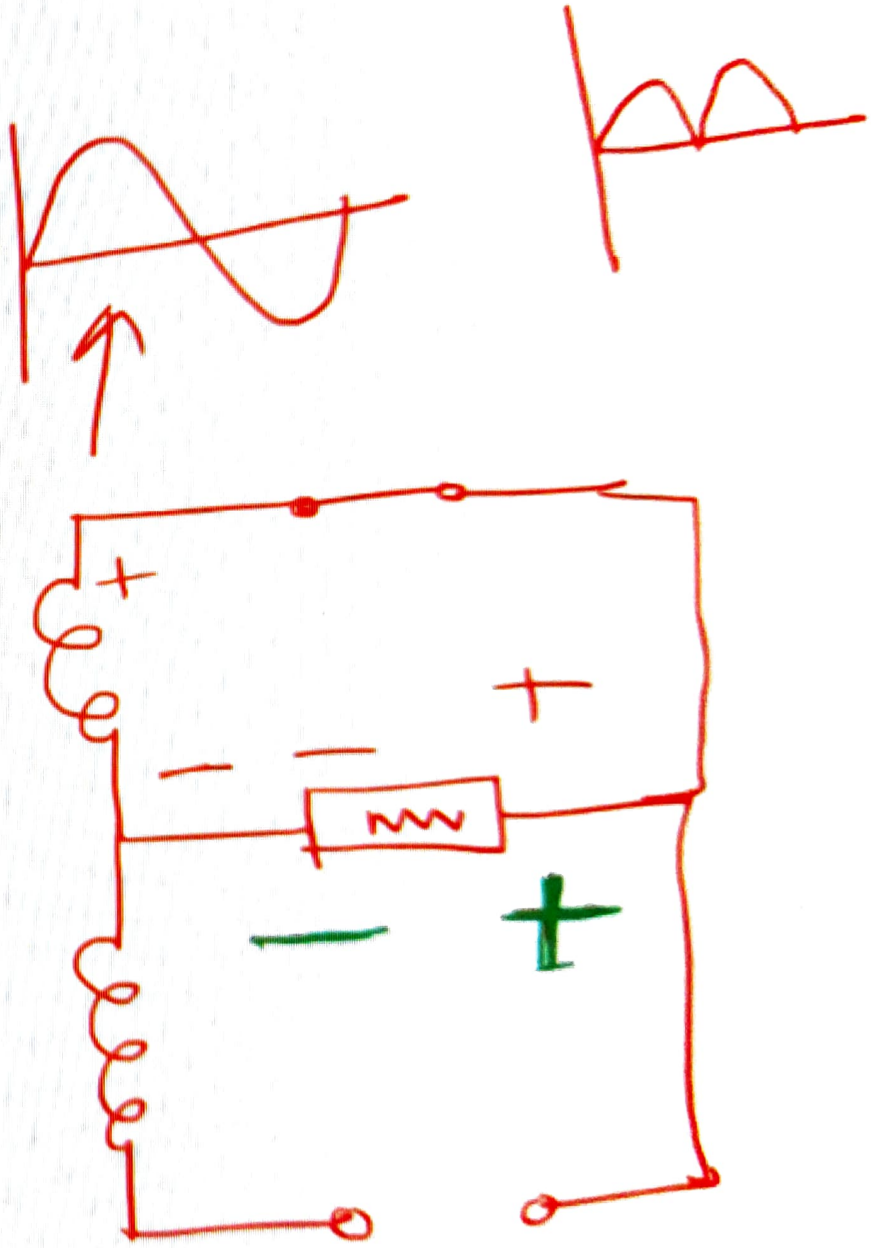
$$V_{avg} = \frac{V_m}{\pi}$$

$$V_{rms} = \frac{V_m}{2}$$

$$\eta = \frac{Output\ power\ (DC)}{Input\ power\ (AC)} = \frac{\frac{V_{avg}^2}{R_L}}{\frac{V_{rms}^2}{R_L}} = 40.53\%$$

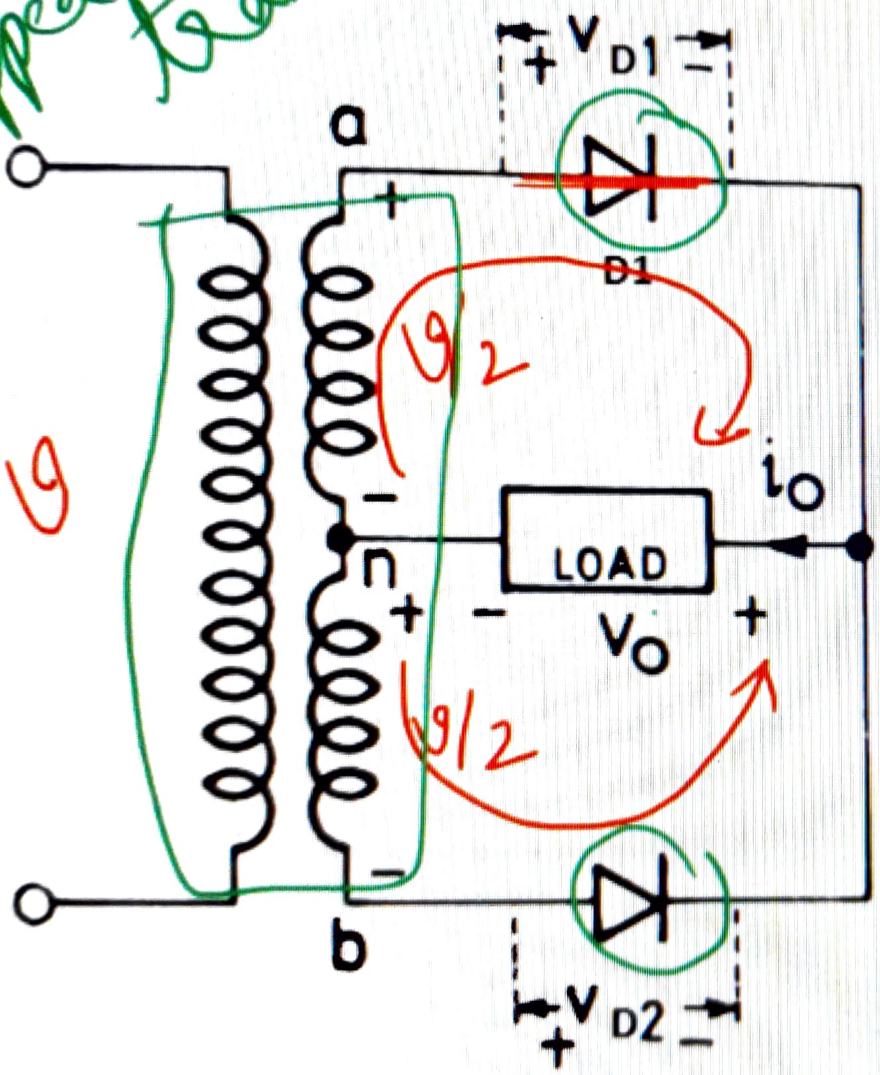
Full-wave rectifier

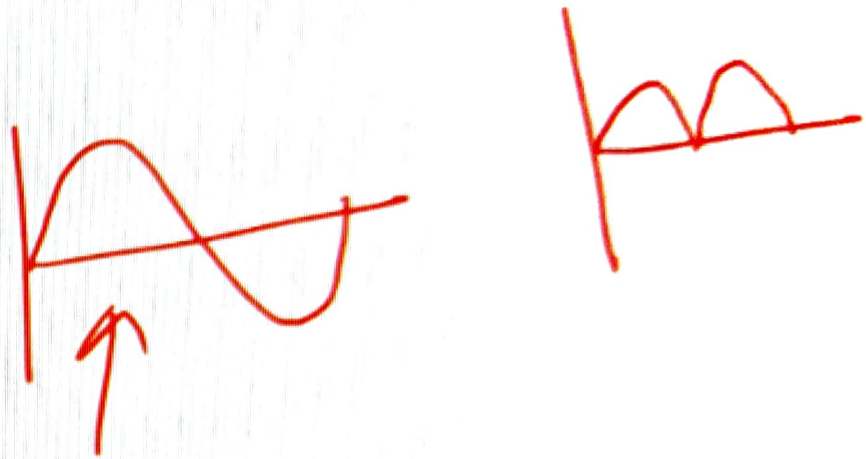


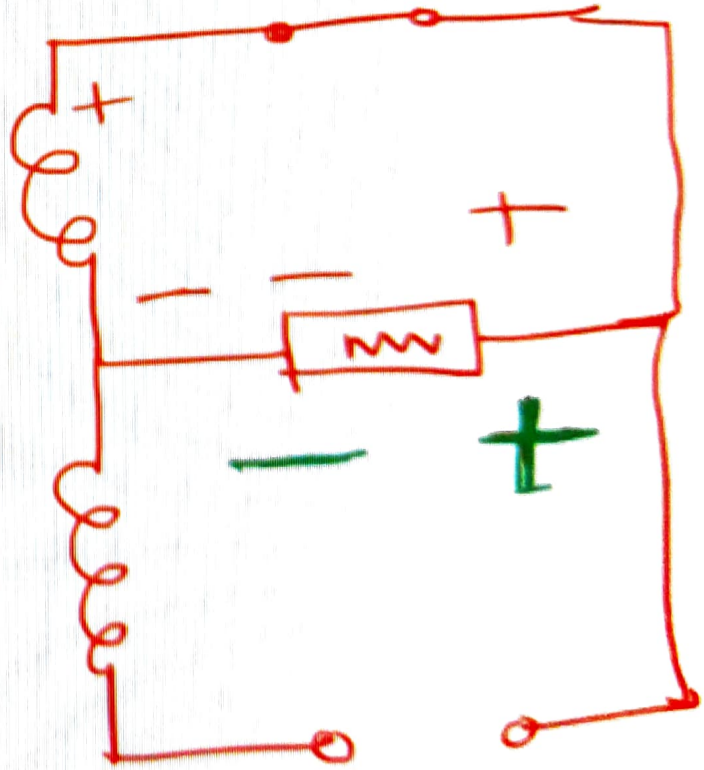


Full-wave rectifier

Centre tapped transformer







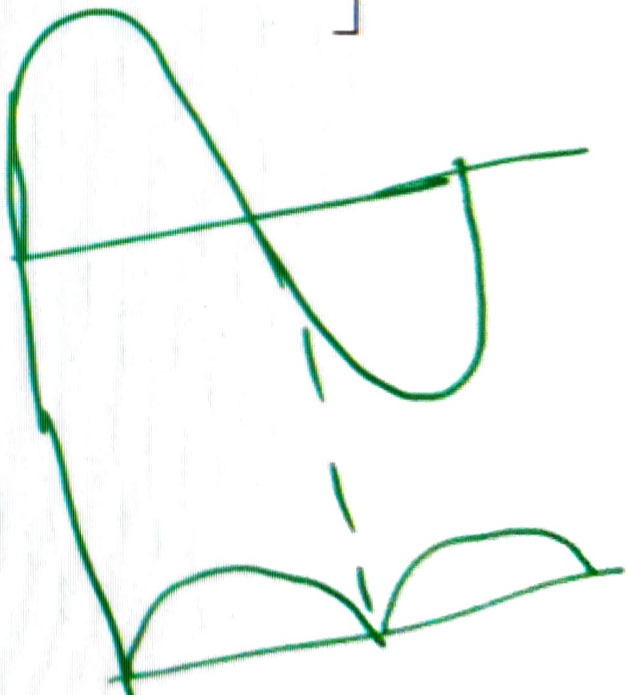
Full-wave rectifier

- RMS value of voltage at the output resistance

$$V_{rms} = \sqrt{\frac{1}{\pi}\left[\int_0^{\pi} v^2 d\theta\right]} = \sqrt{\frac{1}{\pi}\left[\int_0^{\pi} (V_m \sin\theta)^2 d\theta\right]}$$

$$\sin^2\theta = \frac{1-\cos 2\theta}{2}$$

$$V_{rms} = \frac{V_m}{\sqrt{2}}$$

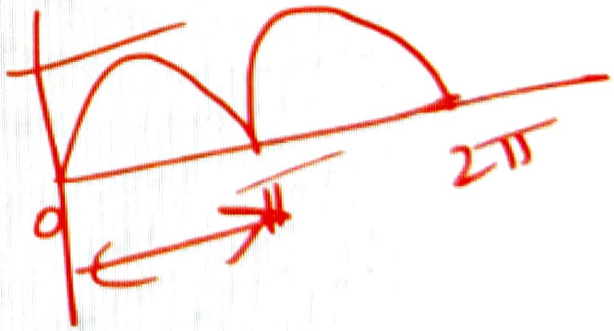


Full-wave rectifier

- Average value of voltage at the output resistance

$$V_{dc} = \frac{1}{\pi}\left[\int_0^{\pi} v\,d(\omega t)\right] = \frac{1}{\pi}\left[\int_0^{\pi} (V_m \sin \omega t)\, d(\omega t)\right]$$

$$V_{dc} = \frac{2V_m}{\pi}$$



Full-wave rectifier

- Ripple factor: indicates how close the rectifier output voltage to its DC value

$$\gamma = \sqrt{\left(\frac{V_{rms}}{V_{dc}}\right)^2 - 1} = 0.482$$

Full-wave rectifier

- Efficiency, η is the ratio of output power (dc) to input power (ac)

$$\eta = \frac{Output\ power\,(DC)}{Input\ power\,(AC)} = \frac{\frac{V_{dc}^2}{R_L}}{\frac{V_{rms}^2}{R_L}} = 81.2\%$$

Full-wave rectifier

- Form factor: ratio of the rms value of the output voltage to the average value of the output voltage

$$\text{Form factor} = \frac{\text{RMS value of output voltage}}{\text{Average value of output voltage}}$$

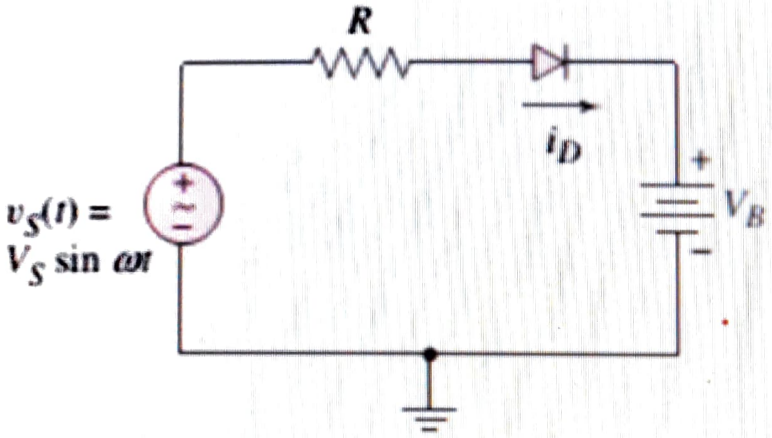
$$\text{Form factor} = \frac{\frac{V_m}{\sqrt{2}}}{\frac{2V_m}{\pi}} = 1.11$$

Full-wave rectifier

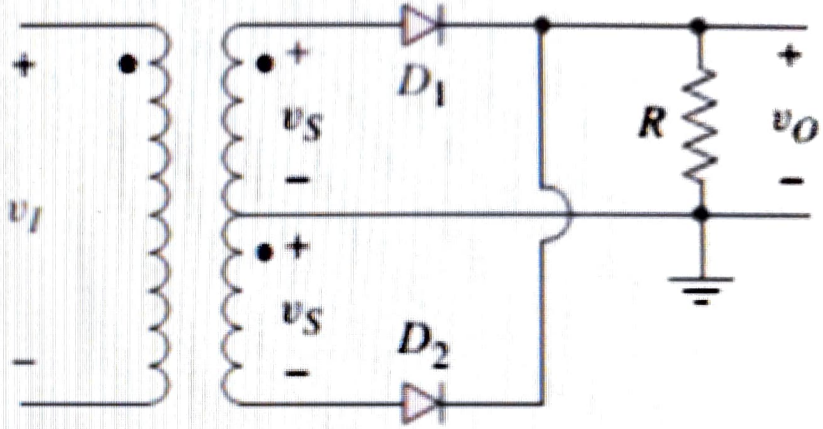
- Peak factor: the ratio of the peak value of the output voltage to the rms value of the output voltage

$$V_{pf} = \frac{\text{Peak value of output voltage}}{\text{RMS value of output voltage}} = \frac{V_m}{V_{rms}} = \sqrt{2}$$

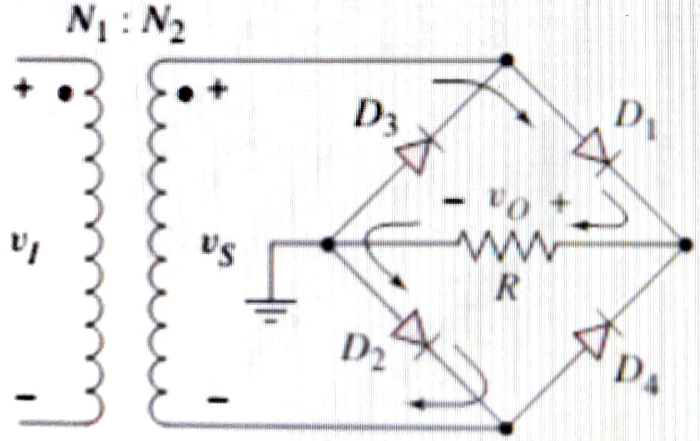
Diode rectifier circuits

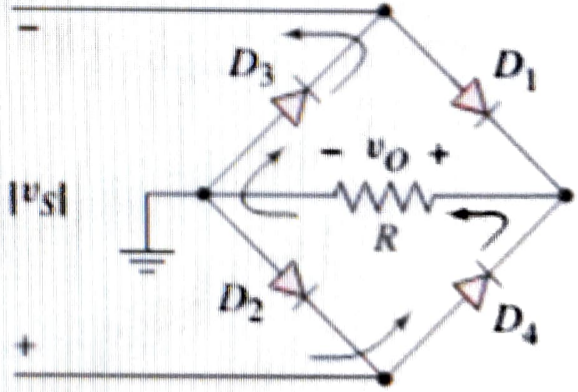


Half wave rectifier



Full wave rectifier,
centre tapped transformer





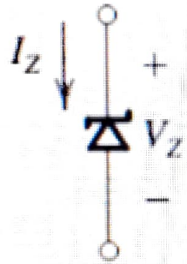
Full wave bridge rectifier

Passive filters

- To smoothen the ripple
  - Inductor filter
  - Capacitor filter
  - LC filter
  - CLC or pi filter

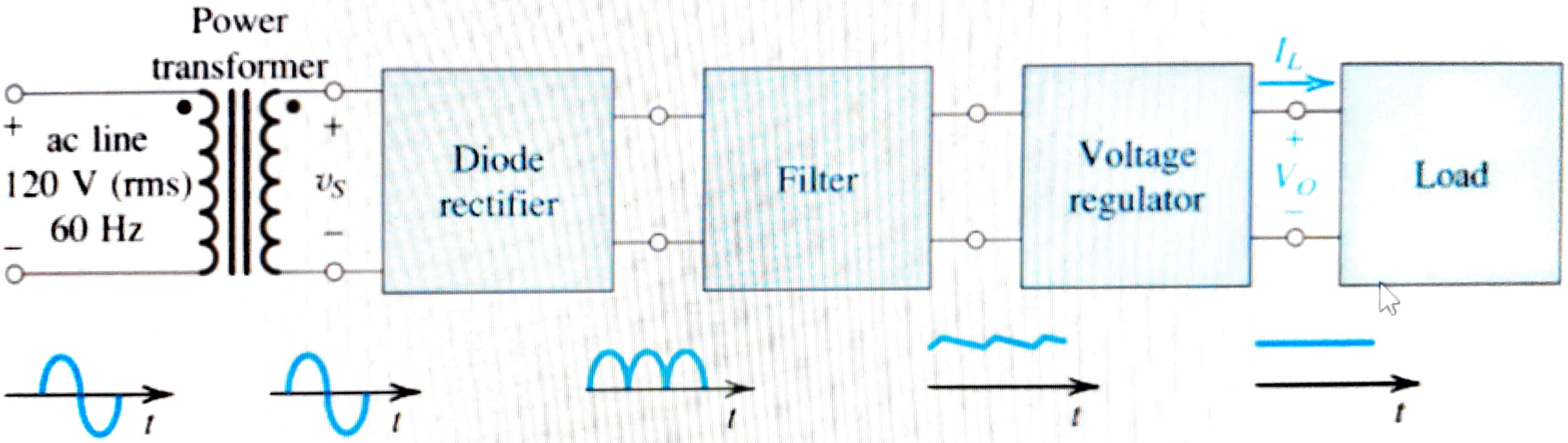
Voltage regulator

- Provides constant DC voltage to the circuit
- Zener diode is a voltage regulator

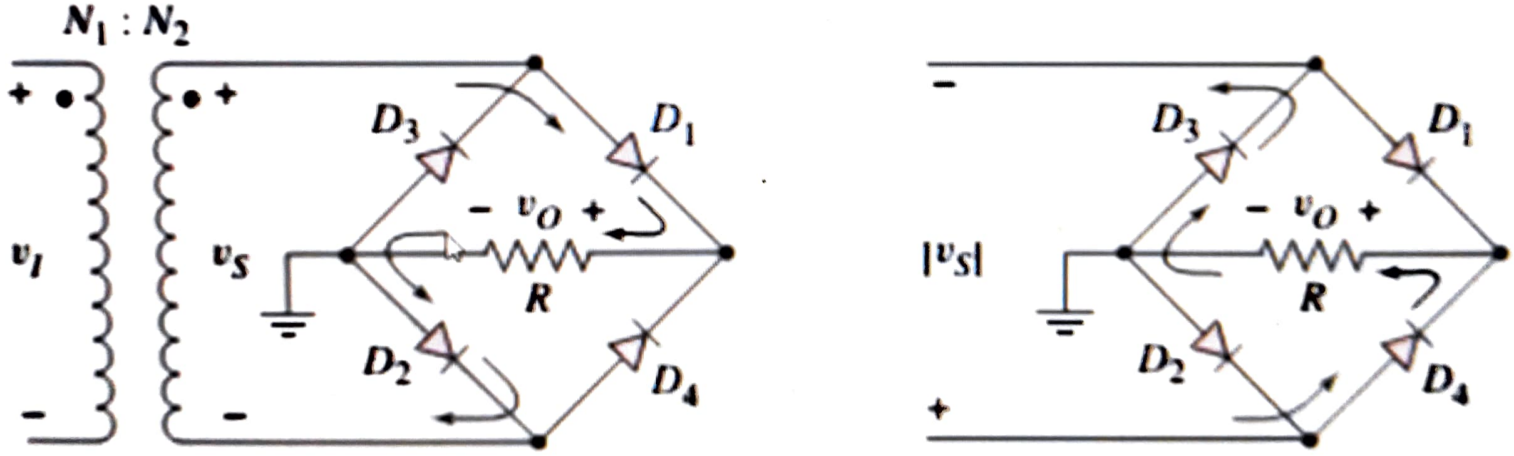


- The first integrated voltage regulator (μA723, National LM100)

Regulated DC power supply/ **Cell Phone Charger Circuit**



- Input voltage v_1 = 220 V, 50 Hz. Turns ratio is 10:1. Load resistance is 1 kΩ. Determine the RMS and DC load voltage and load current. Draw the waveforms.



Transformer eqn. $\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$

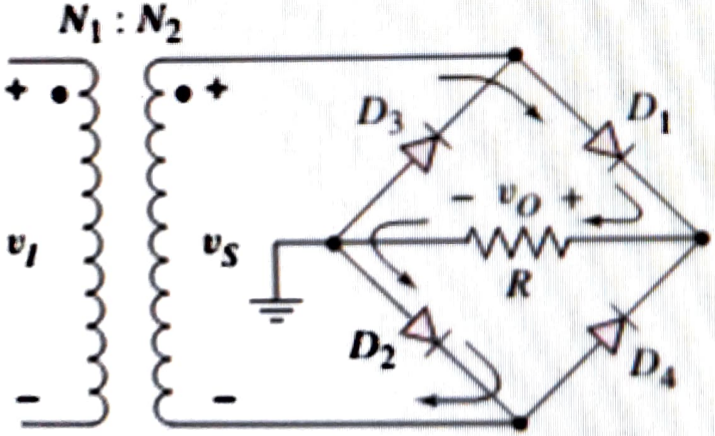
$$\frac{v_1}{v_s} = \frac{N_1}{N_2} \Rightarrow \frac{220}{v_s} = \frac{10}{1} \Rightarrow v_s = 22 \text{ V (RMS)}$$

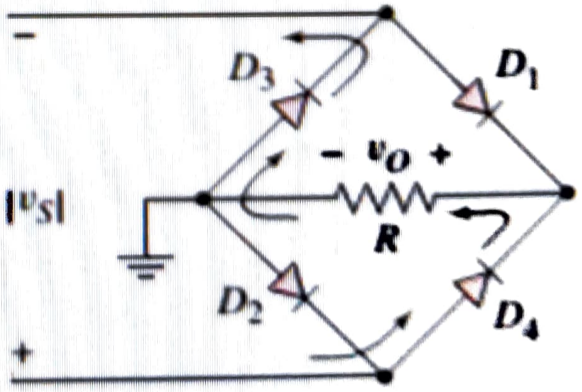
$$V_{DC} = ?$$

$$V_m = V_{RMS}\sqrt{2}$$

$$I_{RMS} = \frac{22}{1k} = 22\,\text{mA}$$

$$I_{DC} = ?$$



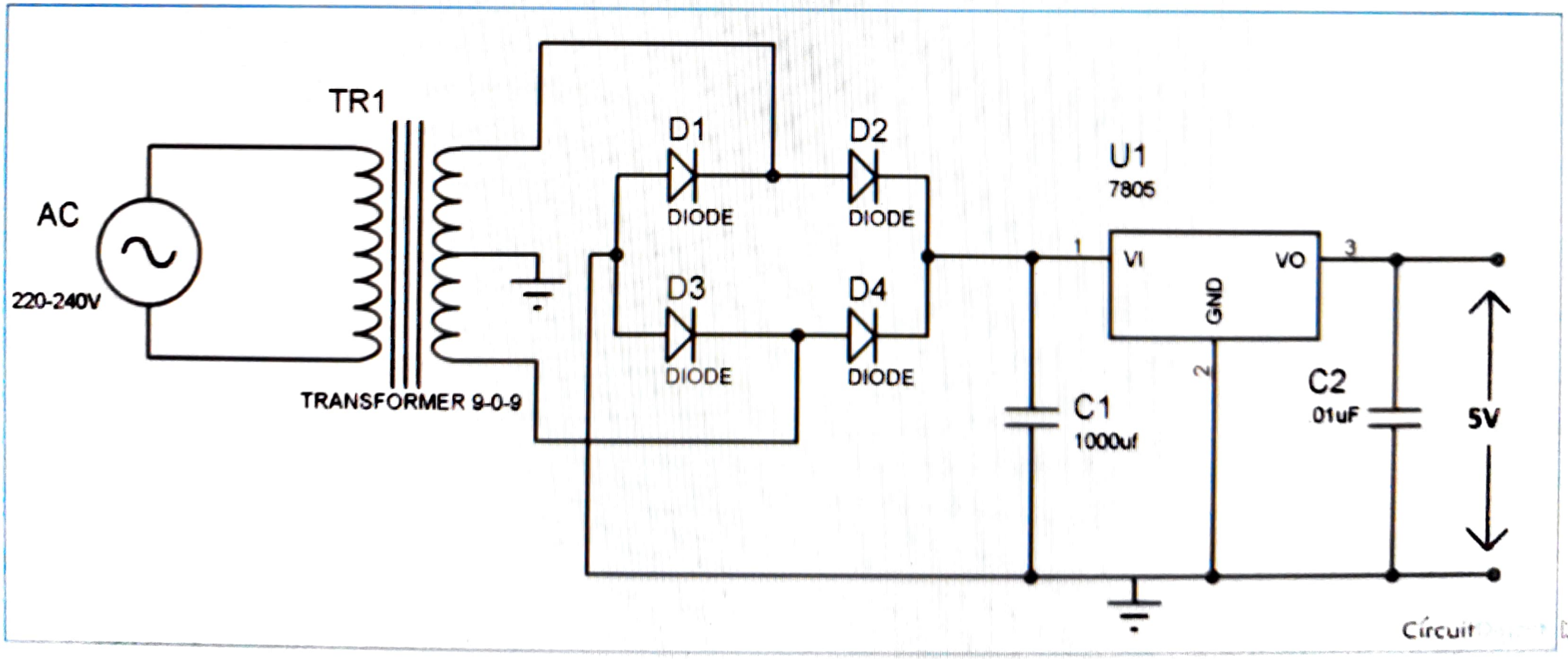


- In a full wave bridge rectifier, input voltage on transformer side with a turns ratio of 5:1 is given by $v_1 = 170 \sin(\omega t)$, where $f = 60$ Hz. The load resistance is 1 kΩ. Determine the RMS and average load voltage and load current.

Circuit: 5v regulated DC supply

Circuit consists of

1. Step down transformer
2. Diode bridge rectifier
3. Filter
4. Voltage Regulator

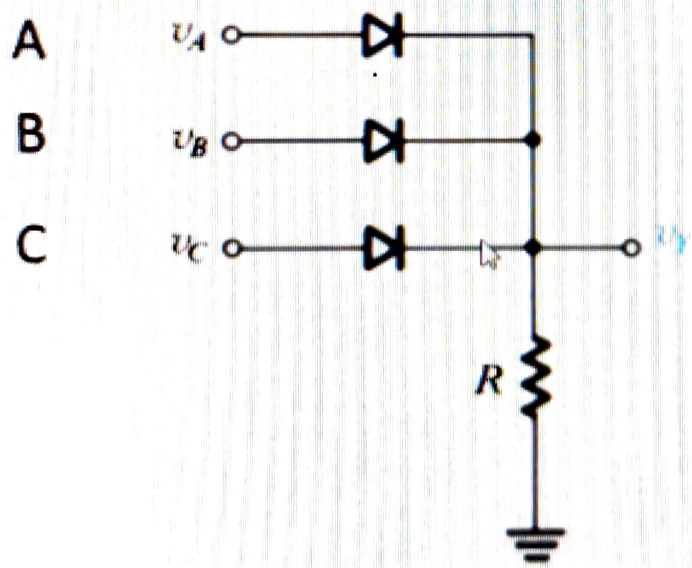


5v regulated DC supply from 220 V AC/ Cell Phone Charger Circuit

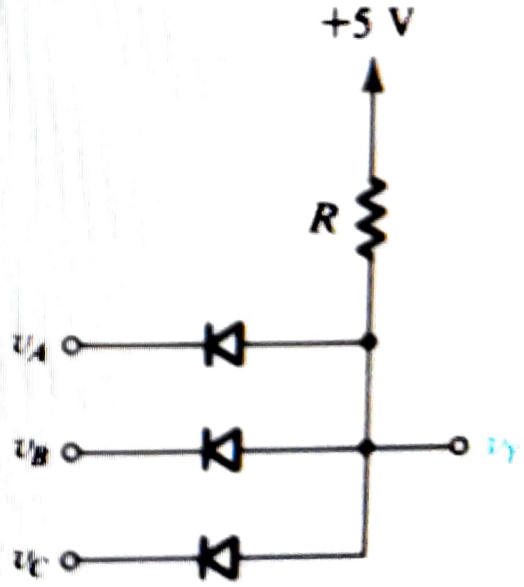
- Mobile phones are generally charged with **5v regulated DC supply**
- Objective: To build a 5v regulated DC supply from 220 V AC
- This DC supply can be used to
  - charge mobiles
  - Power source for digital circuits, breadboard circuits, ICs, microcontrollers etc
- You can also build 6V, 9V, 12V, 15V DC etc.

Application of Diodes: Logic Gates

- The **logic OR function**
  - Y=A+B+C
- The **logic AND function**
  - Y=A·B·C



(a)



(b)