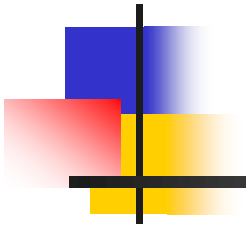


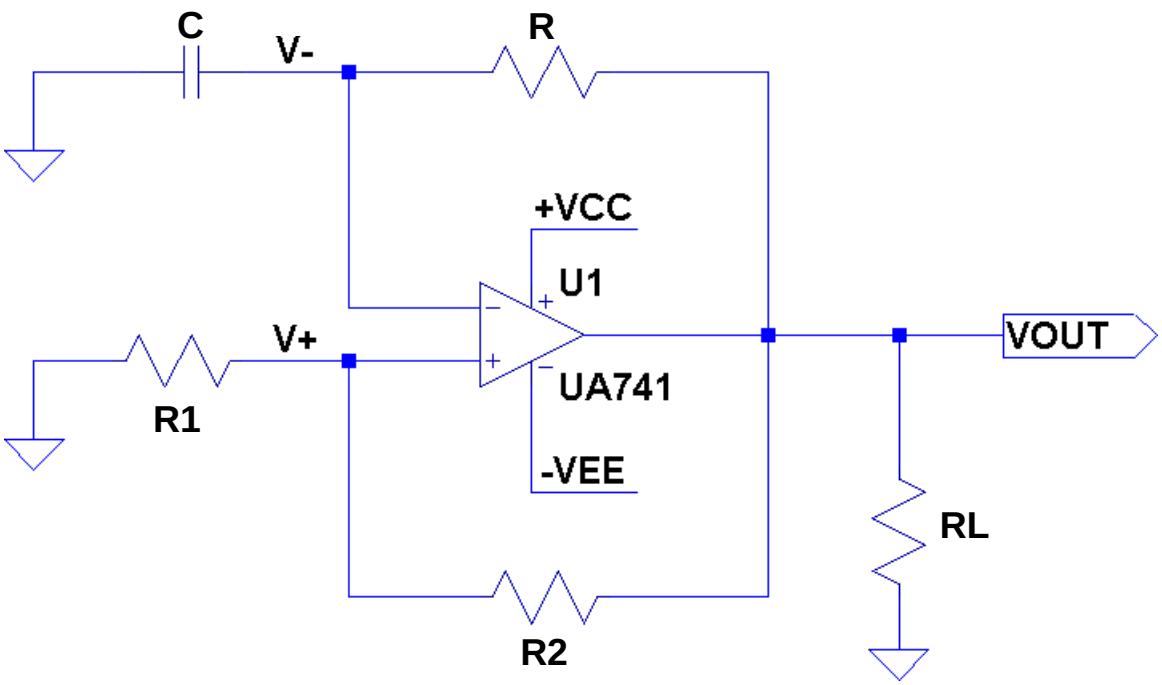
Electronic Circuits Design

Lecture – 6

- *Square Waveform Generator*
- *Triangular Waveform Generator*

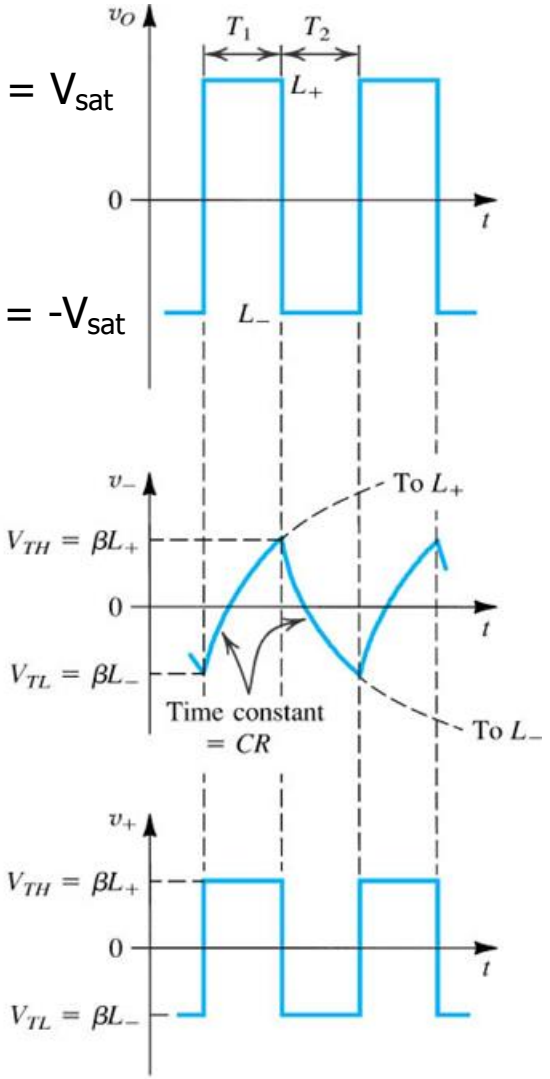
Yeonbae Chung
School of Electronics Engineering
Kyungpook National University

Square Waveform Generator - 1



$L_+ = V_{sat}$

$L_- = -V_{sat}$



$$\beta = \frac{R1}{R1 + R2}$$

Square Waveform Generator - 1

- RC charging and discharging voltage: $v(t) = V_\infty - (V_\infty - V_{0+})e^{-\frac{t}{RC}}$

- During T_1: ➔ charging

$$V_- = V_{sat} - (V_{sat} + \beta V_{sat})e^{-\frac{t}{RC}} \quad \Rightarrow \quad T_1 = RC\ln(\frac{1+\beta}{1-\beta})$$

- During T_2: ➔ discharging

$$V_- = -V_{sat} - (-V_{sat} - \beta V_{sat})e^{-\frac{t}{RC}} \quad \Rightarrow \quad T_2 = RC\ln(\frac{1+\beta}{1-\beta})$$

$$\Rightarrow \quad T = T_1 + T_2 = 2RC\ln(\frac{1+\beta}{1-\beta}) = 2RC\ln(\frac{2R1+R2}{R2})$$

If R2 = 1.16R1 ➔ $T = 2RC\ln(\frac{3.16}{1.16}) = 2RC$

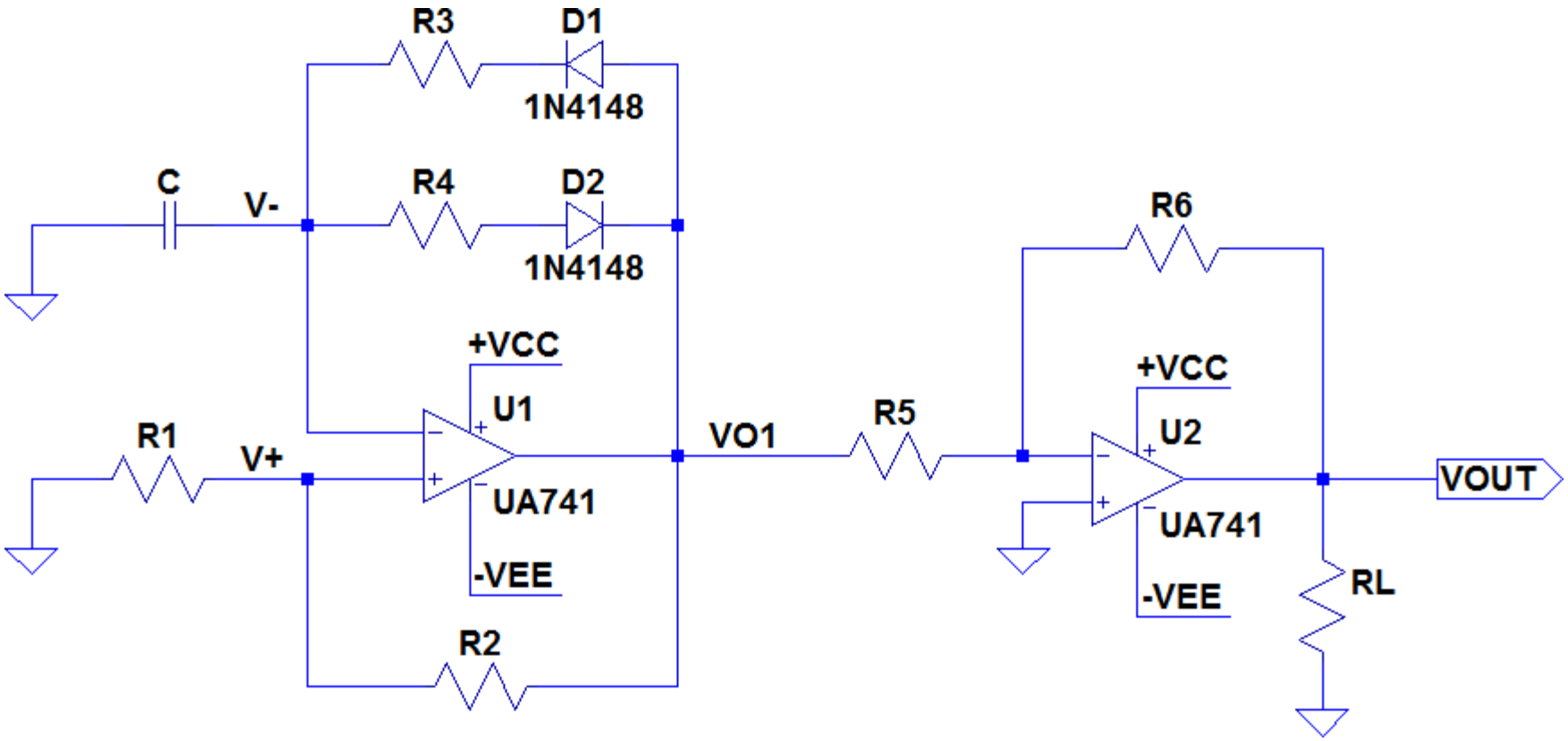
$$f = \frac{1}{T} = \frac{1}{2RC}$$

Lab-1: Square Waveform Generator - 1

- **Simulation Condition**
  - **Op Amp: µA741**
  - **RL = 5 kΩ**
  - **+VCC = 15 V, -VEE = -15 V**
  - **Transient analysis**

1) **Design the square waveform generator with f = 100 Hz, and obtain a plot of V+, V- and VOUT versus time.**
2) **Design the square waveform generator with f = 500 Hz, and obtain a plot of V+, V- and VOUT versus time.**
3) **Make a comment on your design if you need.**

Square Waveform Generator - 2

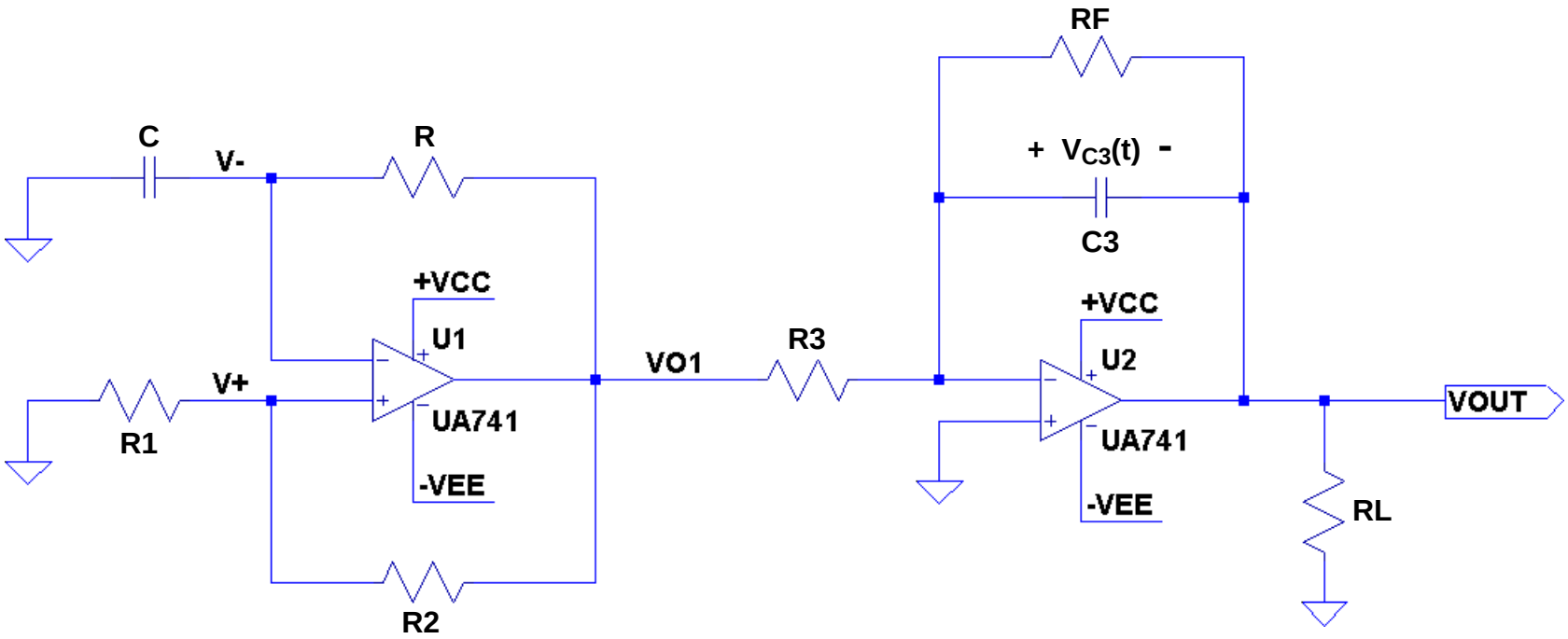


Lab-2: Square Waveform Generator - 2

- **Simulation Condition**
  - **Op Amp: µA741**
  - **Diode: 1N4148**
  - **RL = 5 kΩ**
  - **+VCC = 15 V, -VEE = -15 V**
  - **Transient analysis 0 to 10ms**

1) **Design the square waveform generator whose clock frequency is 1 kHz with 6-V peak-to-peak and 60 % duty cycle. Obtain a plot of V+, V-, VO1 and VOUT versus time.**
2) **Design the square waveform generator whose clock frequency is 1 kHz with 6-V peak-to-peak and 25 % duty cycle . Obtain a plot of V+, V-, VO1 and VOUT versus time.**
3) **Make a comment on your design if you need.**

Triangular Waveform Generator



$$VOUT \cong -\frac{1}{R3C3}\int_0^t VO1(t)dt - V_{C3}(t=0)$$

Lab-3: Triangular Waveform Generator

❖ **Simulation Condition**

- **Op Amp: μA741**
- **RL = 5 kΩ, RF = 200 kΩ**
- **+VCC = 15 V, -VEE = -15 V**
- **Transient analysis 0 to 16ms**

1) **Design the triangular waveform generator to provide VOUT of a symmetrical triangular wave of 18-V peak-to-peak, 0 average, and 1ms-period after t = 8ms.**
2) **Obtain a plot of V+, V-, VO1 and VOUT versus time.**
3) **Make a comment on your design if you need.**