Faculty of Engineering
Department of Electronics and Communications

GEE336
Electronic Circuits II

Lecture #8
Multivibrators

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Summer 2015

Agenda

Introduction

- Monostable, bistable & Astable

Using 555 Timer

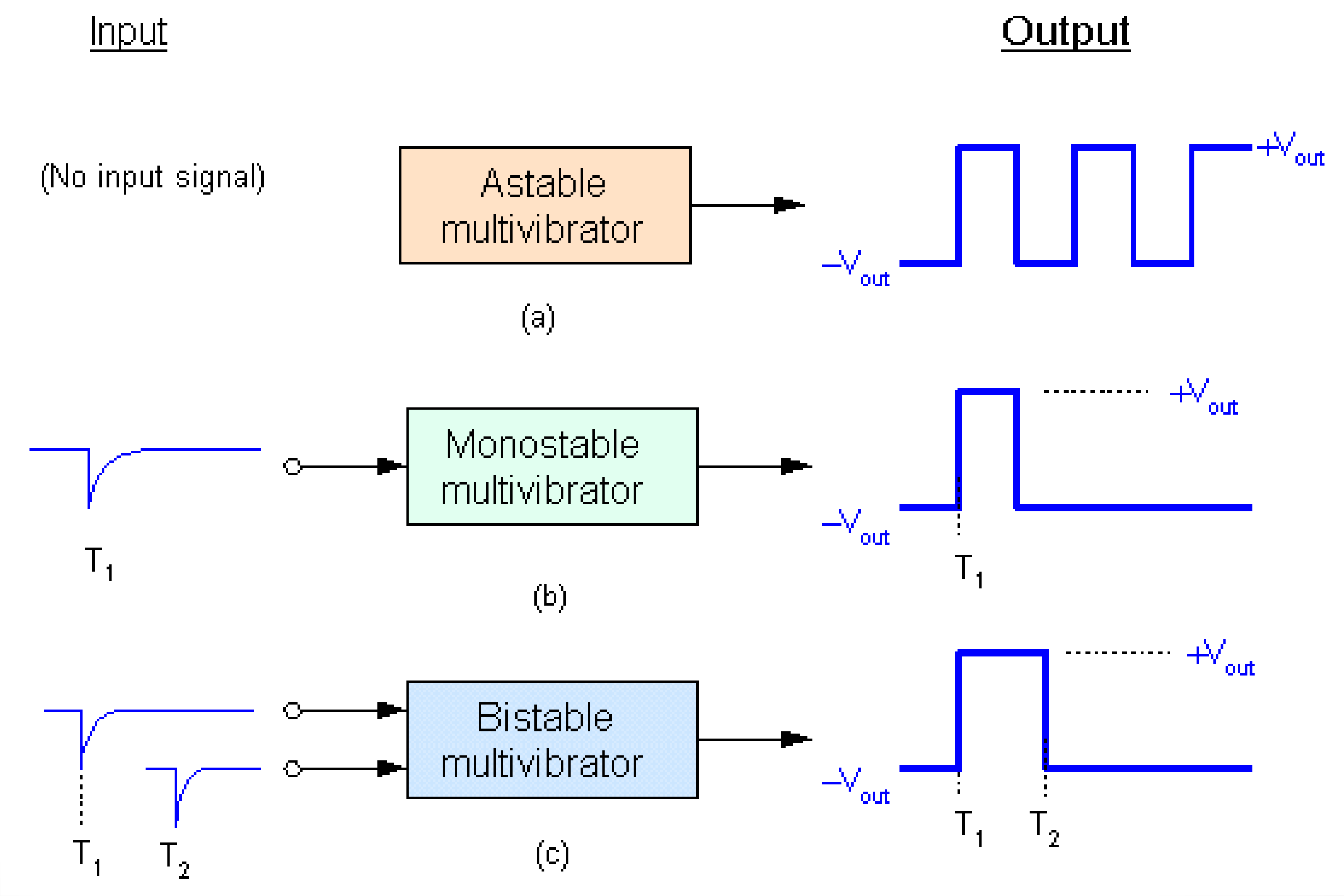
Using Op-AMP

INTRODUCTION

Multivibrators types

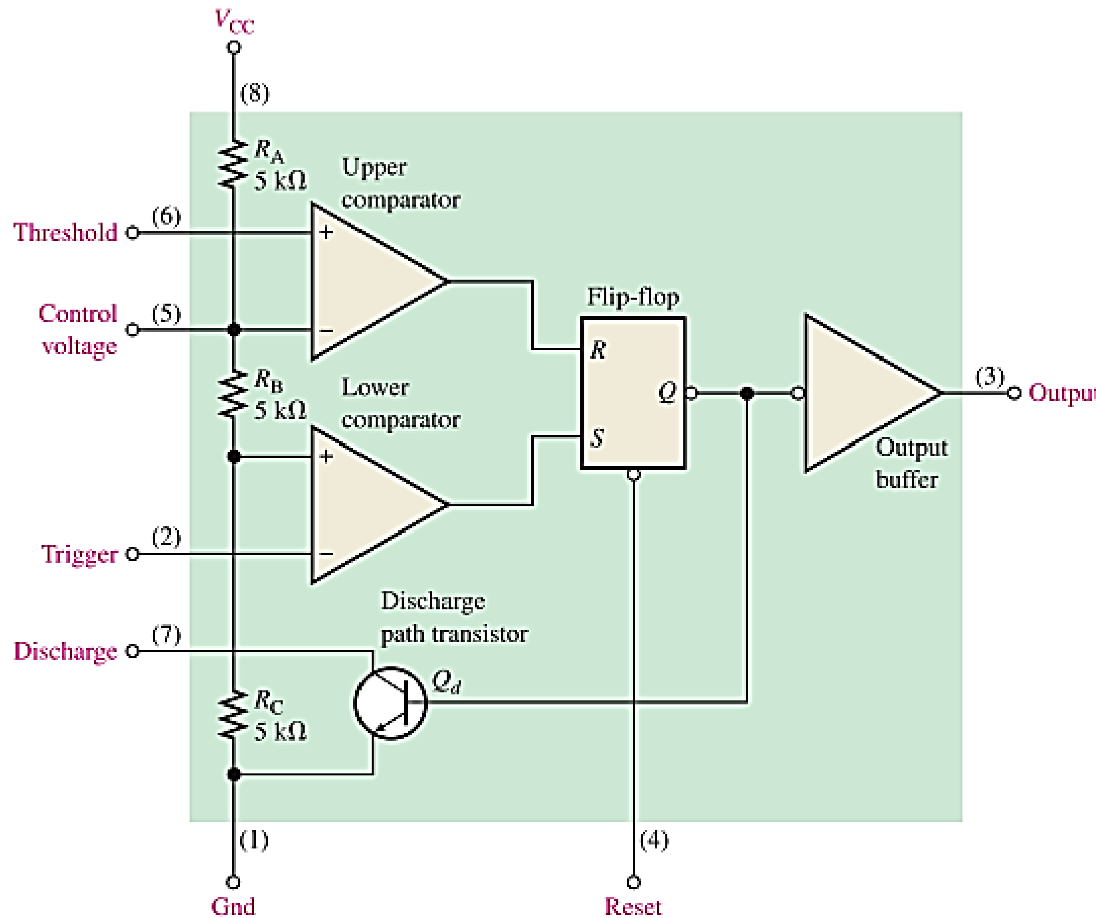
- Monostable
- Bistable
- Astable

Multivibrators types..



MULTIVIBRATORS USING 555 TIMER

555 timer

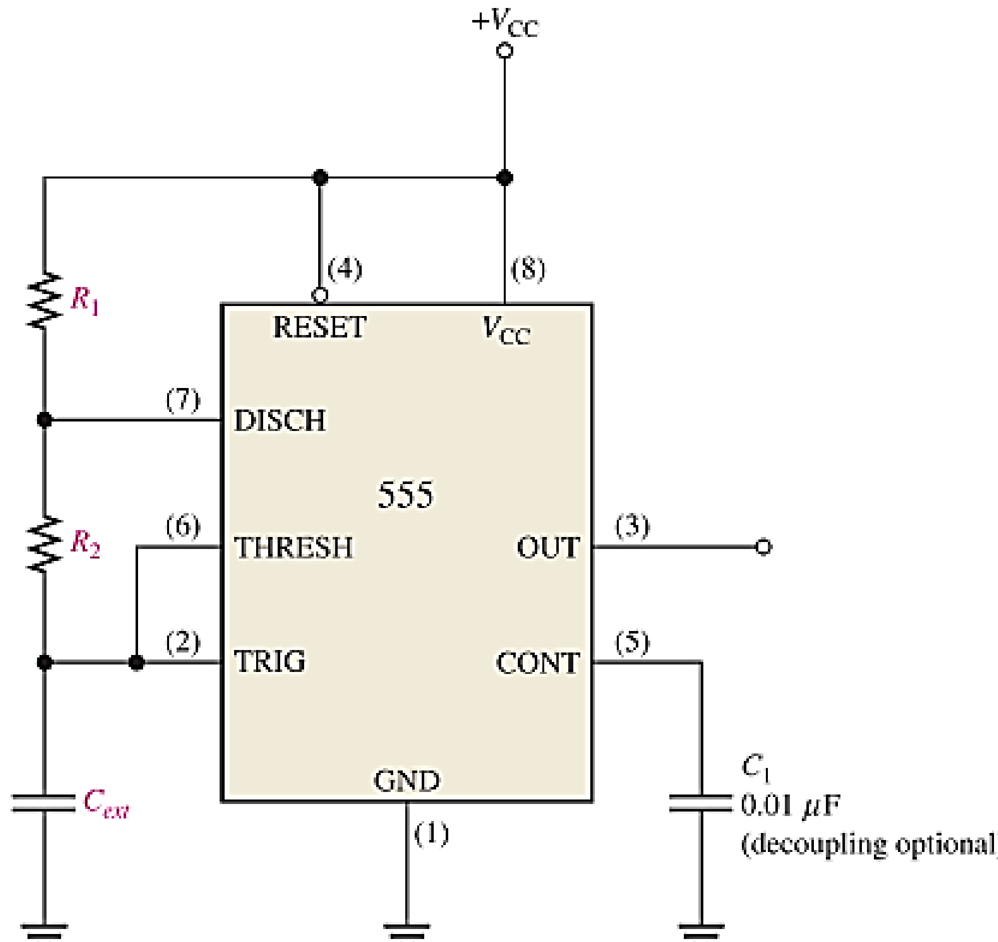


- The 555 timer consists basically of two comparators, a flip-flop, a discharge transistor, and a resistive voltage divider.

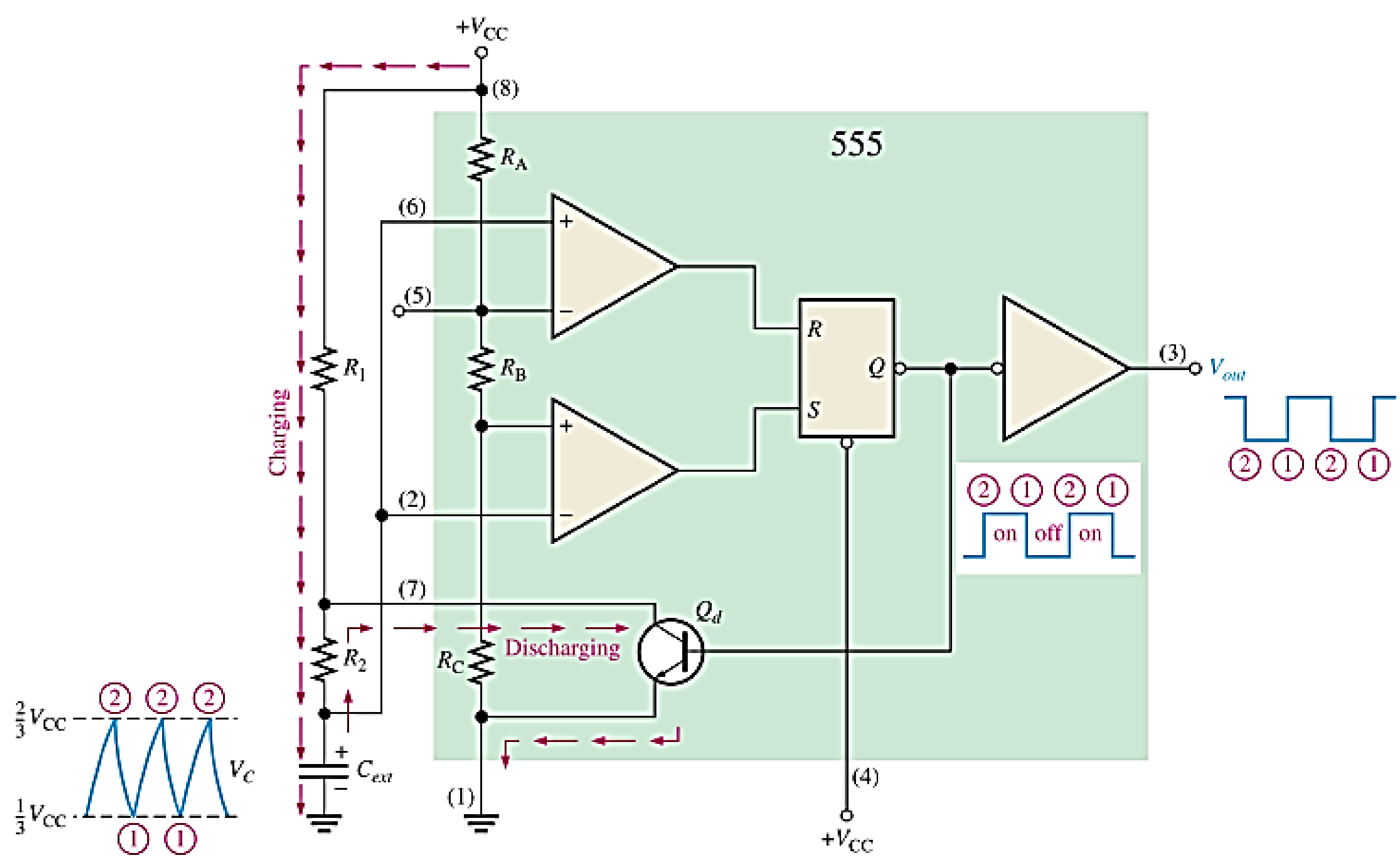
- The flip-flop (bistable multivibrator) is a digital device, a two-state device whose output can be at either a high voltage level (set, S) or a low voltage level (reset, R). The state of the output can be changed with proper input signals.

555 Astable

555 as an astable or free-running multivibrator, which is essentially a square-wave oscillator.



555 Astable..


+VCC
(8)
555
RA
(6)
(5)
R1
RB
Charging
(2)
(7)
R
S
Q
(3)
Vout
Qd
R2
RC
Discharging
2/3 VCC
1/3 VCC
VC
+
Cext
−
(1)
(4)
+VCC
on
off
on

The frequency of oscillation & Duty cycle

$$f_r = \frac{1.44}{(R_1 + 2R_2)C_{ext}}$$

$$t_H = 0.694(R_1 + R_2)C_{ext}$$

$$t_L = 0.694R_2C_{ext}$$

$$T = t_H + t_L = 0.694(R_1 + 2R_2)C_{ext}$$

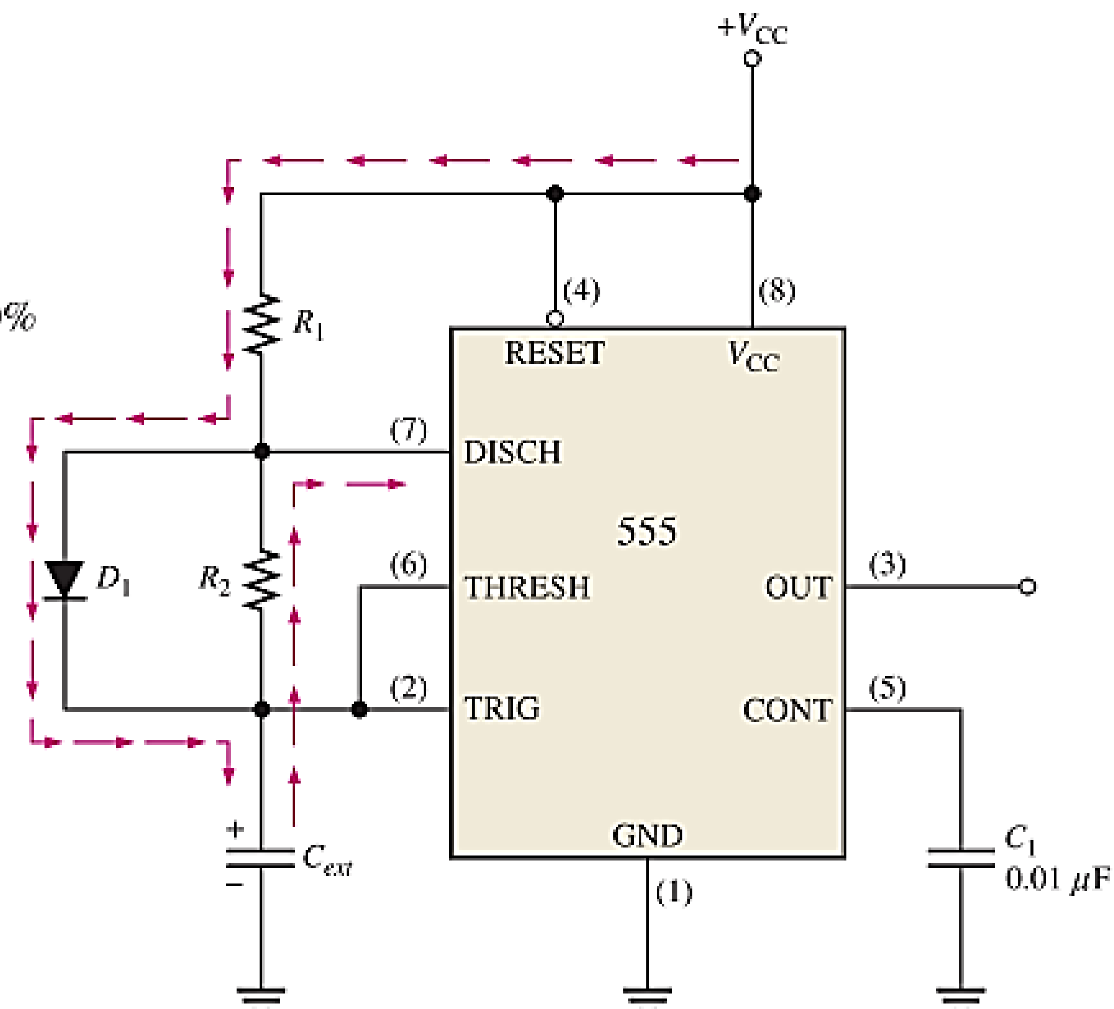
$$\text{Duty cycle} = \left(\frac{t_H}{T}\right)100\% = \left(\frac{t_H}{t_H + t_L}\right)100\%$$

$$\textbf{Duty cycle} = \left(\frac{R_1 + R_2}{R_1 + 2R_2}\right)100\%$$

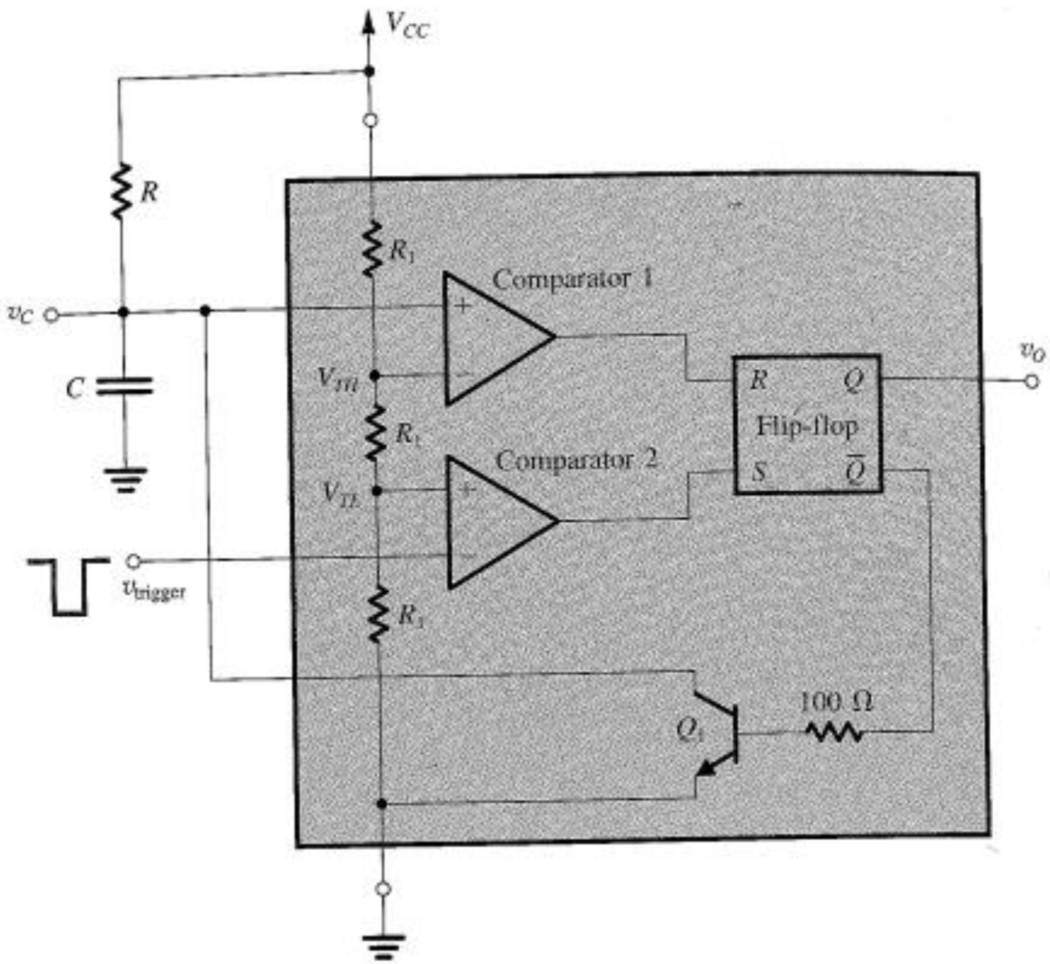
Duty cycles of less than 50%

$$f_r \cong \frac{1.44}{(R_1 + R_2)\,C_{ext}}$$

$$\text{Duty cycle} \cong \left(\frac{R_1}{R_1 + R_2}\right)100\%$$

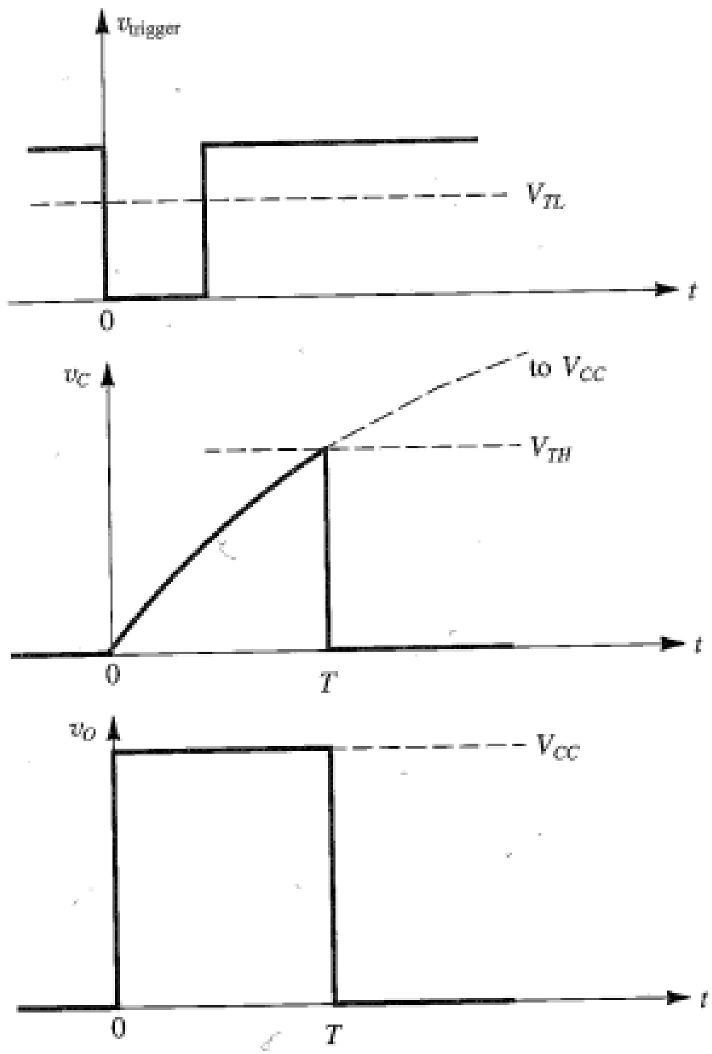


555 Monostable Multivibrator



(a)

555 Monostable Multivibrator..



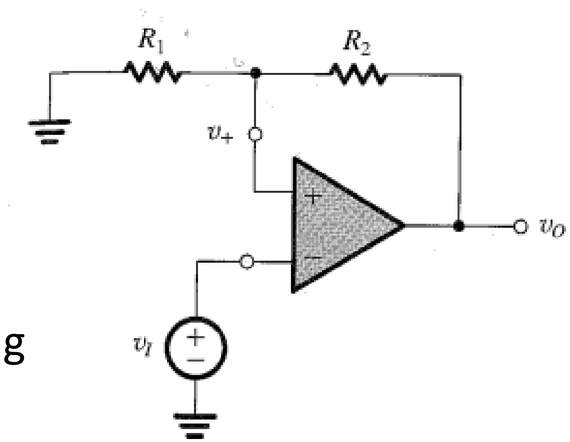
$$v_C = V_{CC}(1 - e^{-t/CR})$$

Substituting $v_C = V_{TH} = \frac{2}{3}V_{CC}$ at $t = T$ gives

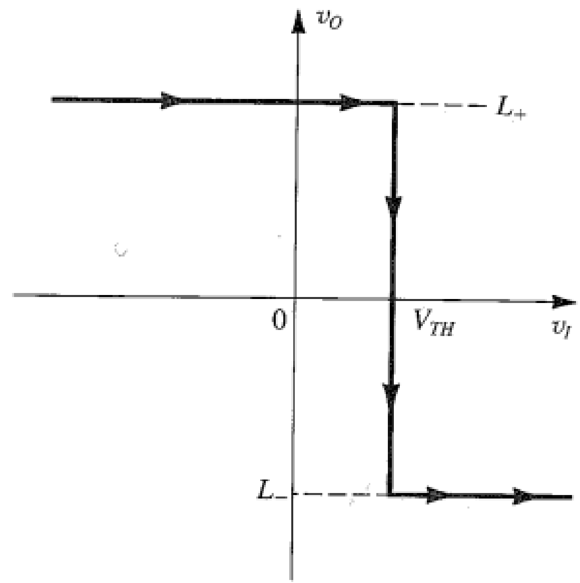
$$T = CR \ln 3 \simeq 1.1CR$$

MULTIVIBRATORS USING OP-AMP

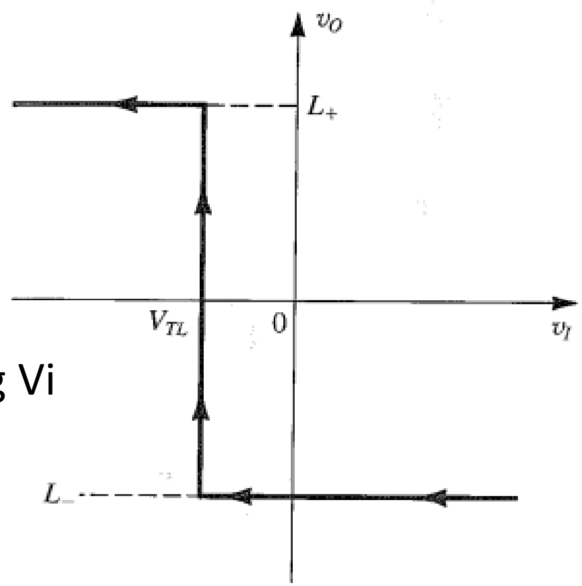
Bistable Circuit and Transfer Characteristic



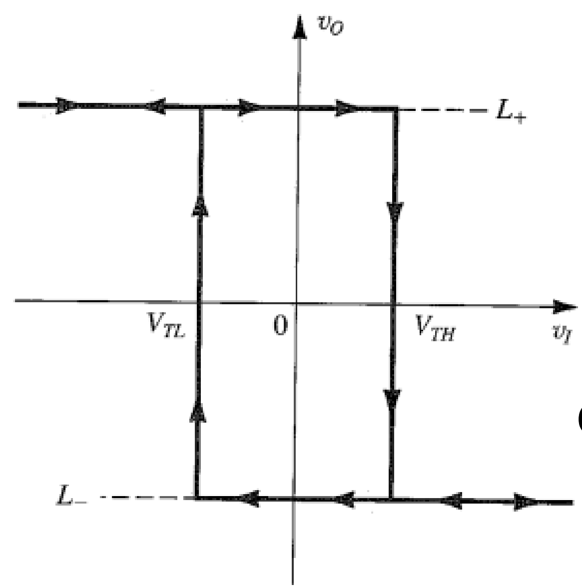
inverting



Increasing Vi

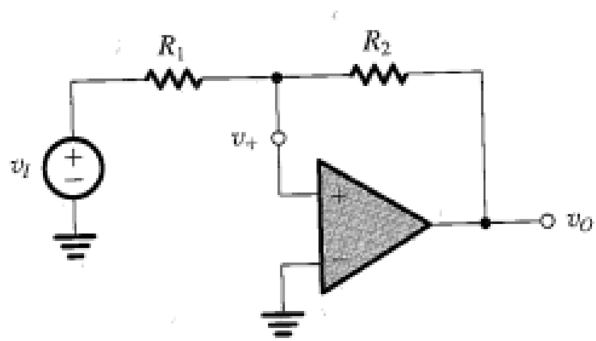


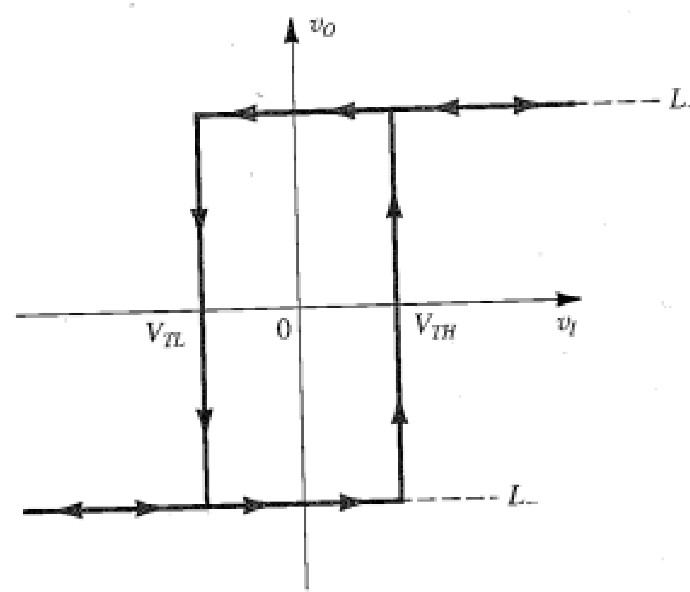
Decreasing Vi



Complete Ch/s

Bistable with non inverting transfer ch/s





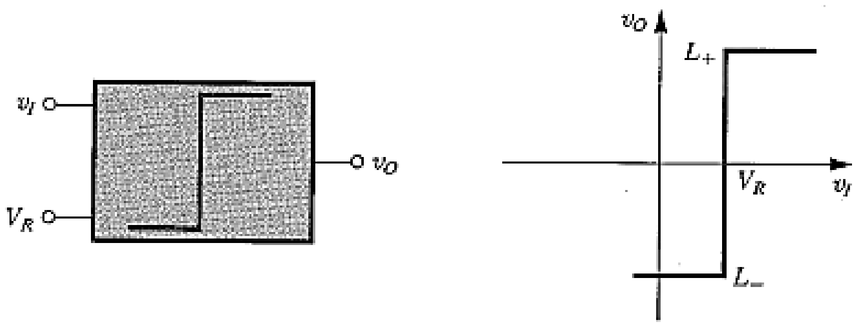
$$v_+ = v_I \frac{R_2}{R_1 + R_2} + v_O \frac{R_1}{R_1 + R_2}$$

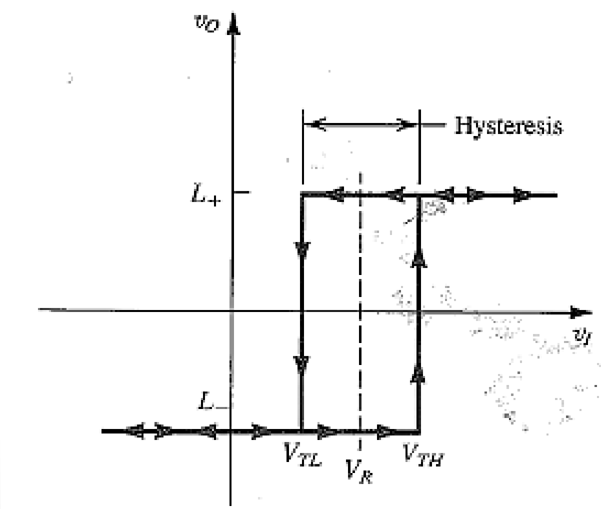
$$V_{TL} = -L_+(R_1/R_2)$$

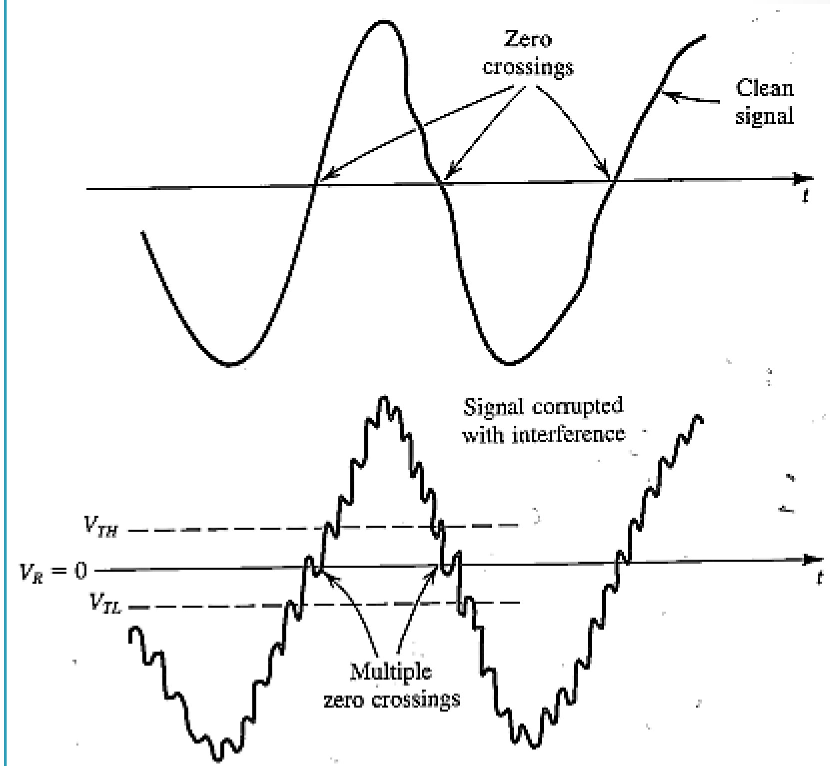
Feed fraction

$$\beta \equiv R_1/(R_1 + R_2)$$

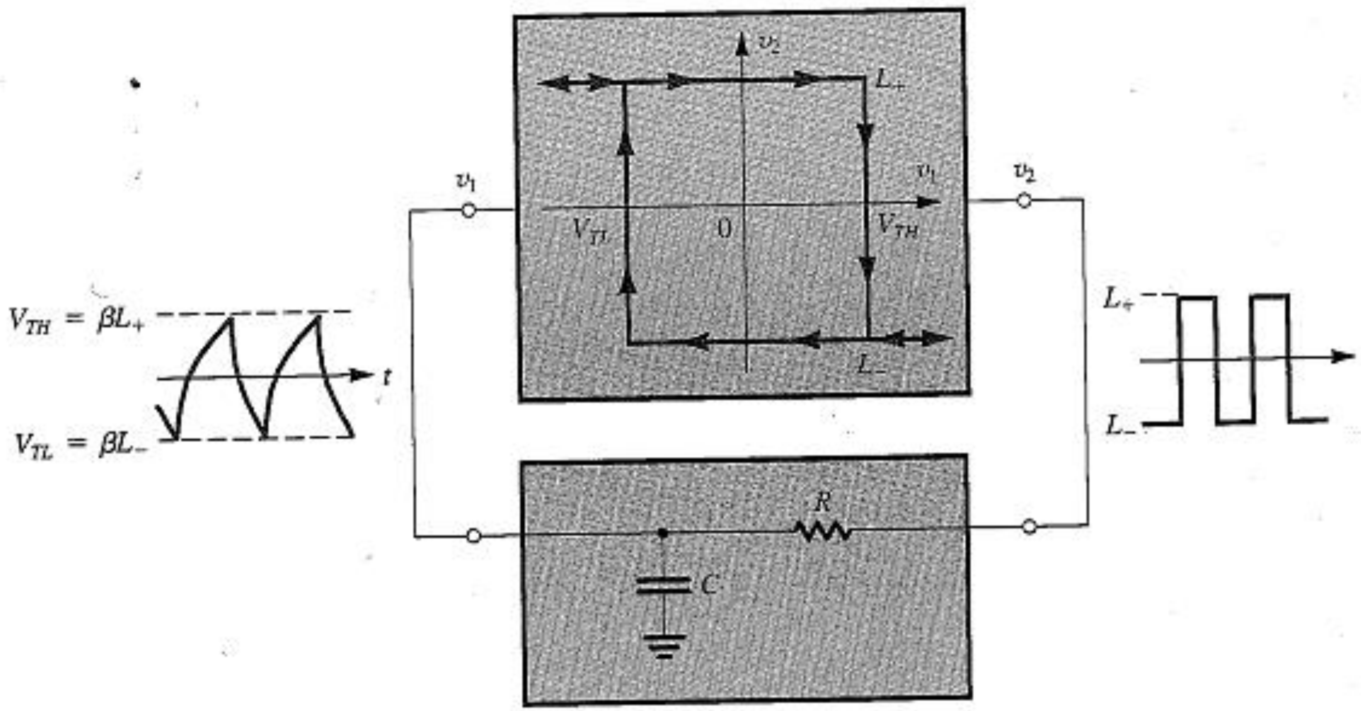
Application of bistable as comparator (Schmit-Trigger)

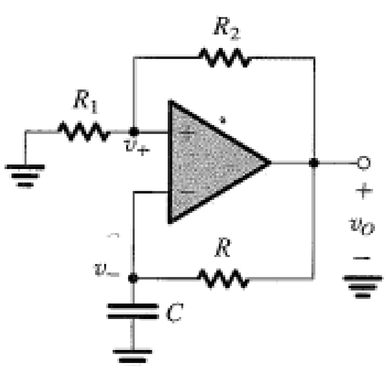




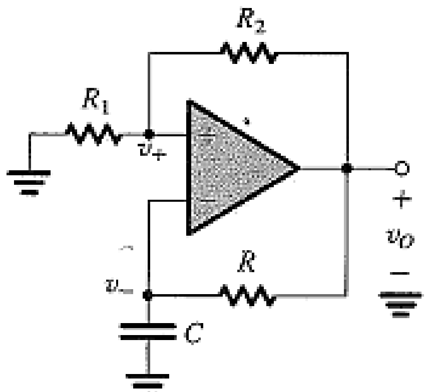


Astable





Astable Circuit ..



Voltage across capacitor:

$$v_- = L_+ - (L_+ - \beta L_-)e^{-t/\tau}$$

Substituting $v_- = \beta L_+$ at $t = T_1$ gives

$$T_1 = \tau \ln \frac{1 - \beta(L_-/L_+)}{1 - \beta}$$

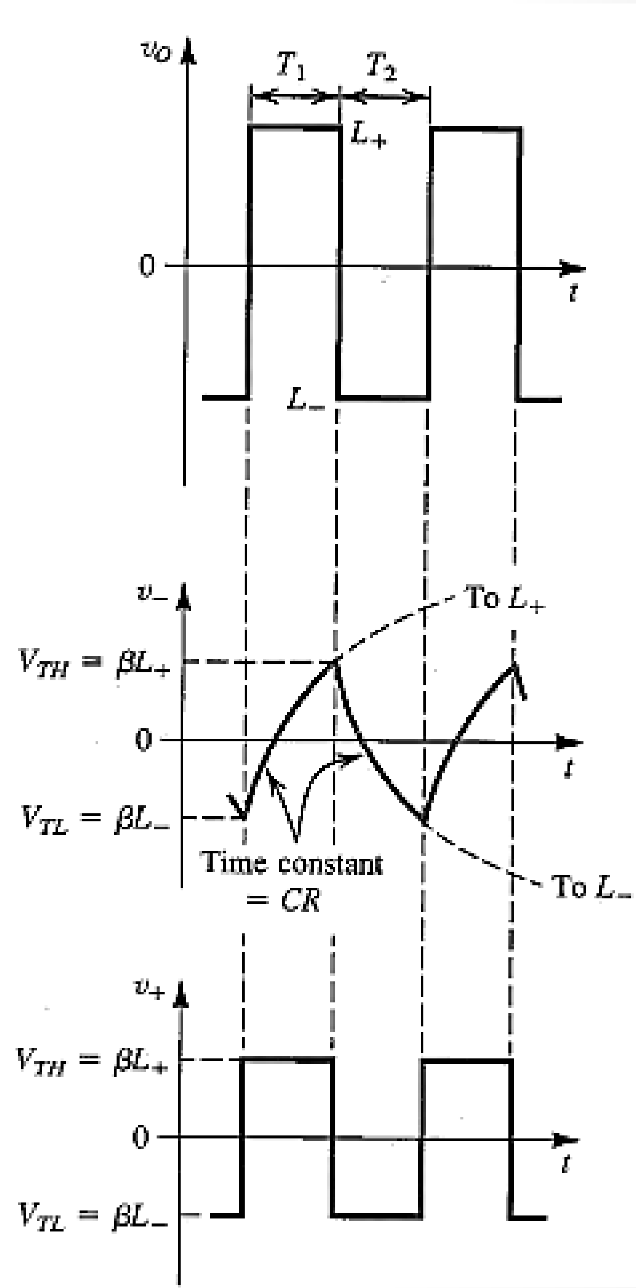
$$v_- = L_- - (L_- - \beta L_+)e^{-t/\tau}$$

$$T_2 = \tau \ln \frac{1 - \beta(L_+/L_-)}{1 - \beta}$$

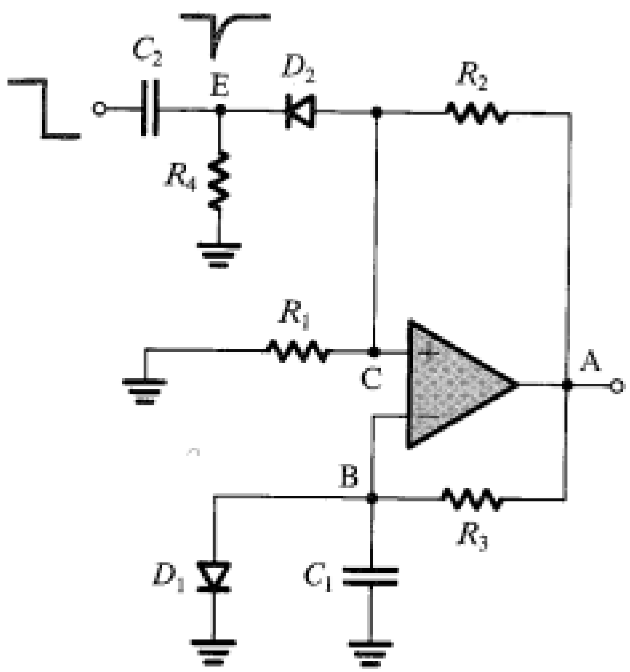
$$T = T_1 + T_2.$$

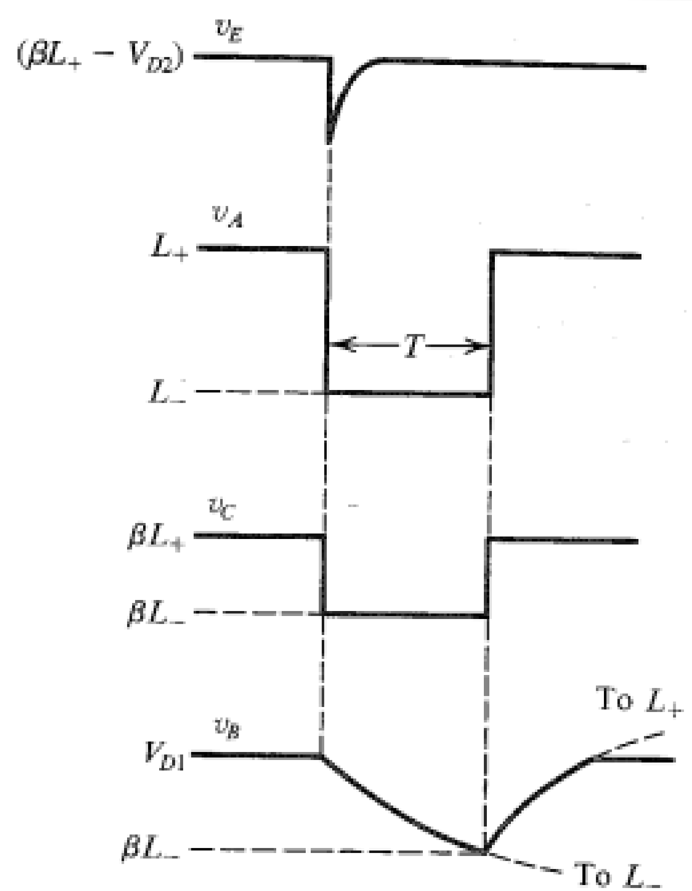
$$\boxed{T = 2\tau \ln \frac{1+\beta}{1-\beta}}$$

$$\tau = CR.$$



Monostable circuit





$$v_B(t) = L_- - (L_- - V_{D1})e^{-t/C_1R_3}$$

by substituting $v_B(T) = \beta L_-$,

$$\beta L_- = L_- - (L_- - V_{D1})e^{-T/C_1R_3}$$

$$T = C_1R_3 \ln\left(\frac{V_{D1} - L_-}{\beta L_- - L_-}\right)$$

$$T \simeq C_1R_3 \ln\left(\frac{1}{1-\beta}\right)$$

- For more details, refer to:
  - Chapter 16 at T. Floyd, **Electronic Devices**,9th edition.
  - Chapter 13 at Sedra, **Microelectronic Circuits**, 5th edition.
- The lecture is available online at:
  - http://bu.edu.eg/staff/ahmad.elbanna-courses/12884
- For inquires, send to:
  - ahmad.elbanna@feng.bu.edu.eg