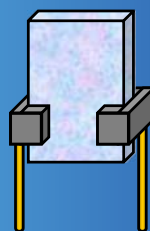


Analog Electronics

Lecture #5

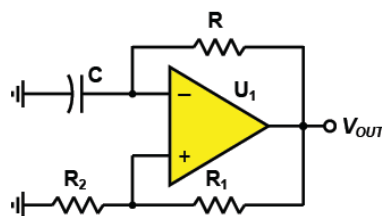
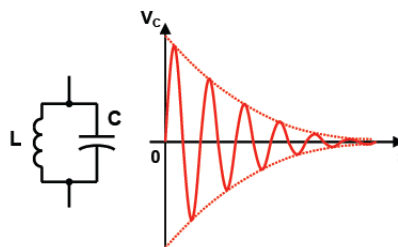
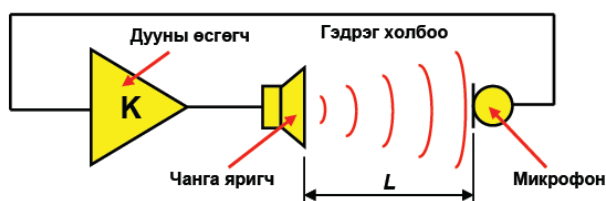


Signal generators

Ch.10

WHAT IS OSCILLATOR OR GENERATOR?

Цахилгаан хэлбэлзэл бий болгож хувьсах хүчдэл буюу дохио үүсгэдэг төхөөрөмжийг дохионы үүсгүүр - генератор (**oscillator**) гэж нэрлэдэг. Дохионы үүсгүүрийн гаргаж буй дохио нь хугацаанаас хамаарч үелэн давтагдах шинж чанартай байдаг. Дохионы үүсгүүрийг хэлбэлзэл бий болгож байгаа арга замаар нь 1) Гэдрэг холбооны, 2) Резонансын, 3) Релаксацийн гэж гурав ангилдаг.



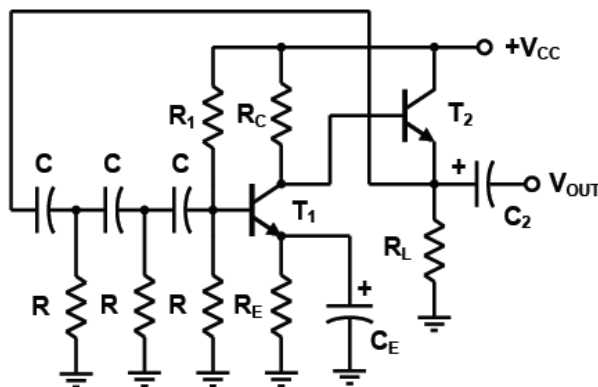
OSCILLATOR FEED BACK CONDITION

$$\dot{\beta} = \beta \cdot e^{i\varphi_{\beta}}; \dot{K} = K \cdot e^{i\varphi_K}$$

$$\dot{\beta} \cdot \dot{K} = \beta \cdot K \cdot e^{i(\varphi_{\beta} + \varphi_K)} = 1 \quad \text{Дохионы үүсгүүр сэргэх нөхцөл}$$

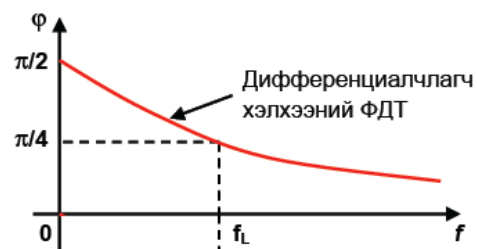
$$\beta \cdot K = 1; \quad \varphi_{\beta} + \varphi_K = 2\pi \cdot n \quad (n = 0, 1, 2, 3 \dots)$$

$$\dot{K}_{F.B} = \frac{\dot{K}}{1 - \dot{K} \dot{\beta}}$$

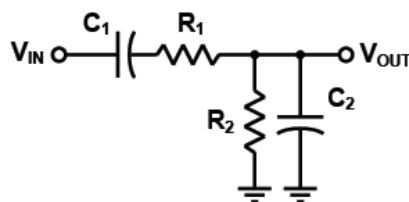


~~$$\omega_o = \frac{1}{\tan(\pi/3) \cdot RC} = \frac{1}{\sqrt{3} \cdot RC}$$~~

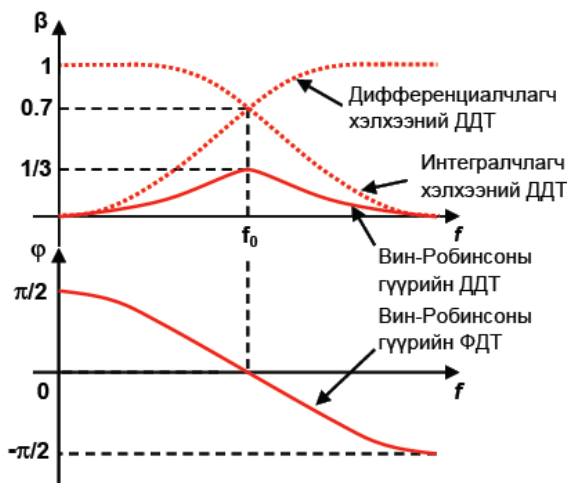
$$\omega_o = \frac{1}{\sqrt{6} \cdot RC}; \quad f_o = \frac{1}{2\pi \sqrt{6} \cdot RC}$$



WIN-ROBINSON BRIDGE



$$\beta = \frac{Z_{R2,C2}}{Z_{R1,C1} + Z_{C2,R2}}$$



$$\varphi_R = \arctg\left(\frac{X_C}{R}\right) = \arctg\left(\frac{1}{\omega RC}\right)$$

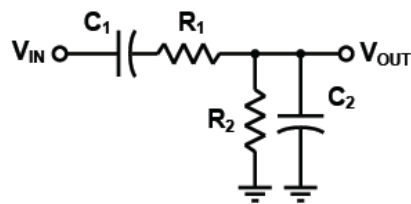
$$\varphi_C = \arctg\left(-\frac{R}{X_C}\right) = \arctg(-\omega RC)$$

$$\frac{1}{\omega_o R_1 C_2} = \omega_o R_2 C_1$$

$$\omega_o = \frac{1}{\sqrt{R_1 C_2 R_2 C_1}}$$

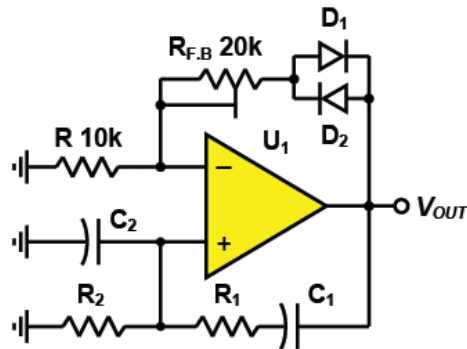
$$f_o = \frac{1}{2\pi \sqrt{R_1 C_2 R_2 C_1}}$$

WIN-ROBINSON OSCILLATOR



$$K = \frac{V_{OUT}}{V_G} = \frac{1}{\sqrt{1 + \omega^2 C^2 R^2}}$$

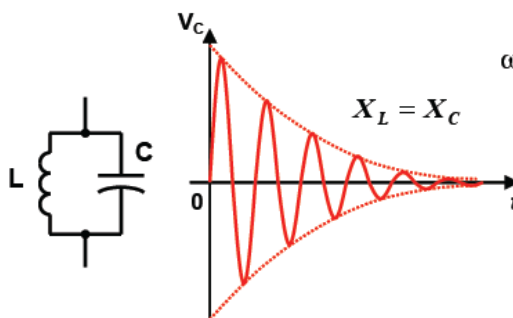
$$K = \frac{V_{OUT}}{V_G} = \frac{R}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}}$$



$$\beta_0 = \frac{1}{1 + R_1/R_2 + C_2/C_1}$$

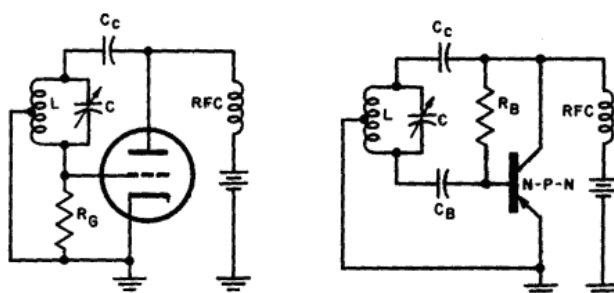
$$R_1 = R_2, C_1 = C_2 \Rightarrow \beta_0 = \frac{1}{3}; f_o = \frac{1}{2\pi RC}$$

OSCILLATOR ON LC RESONATOR

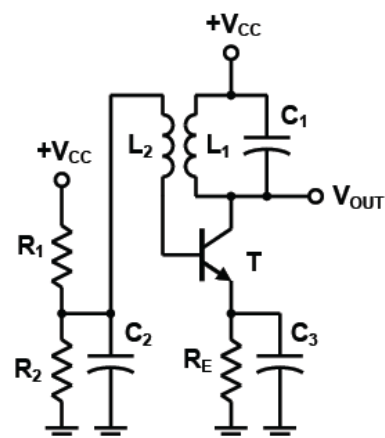


$$\omega_o L = \frac{1}{\omega_o C} \Rightarrow \omega_o = \frac{1}{\sqrt{LC}}$$

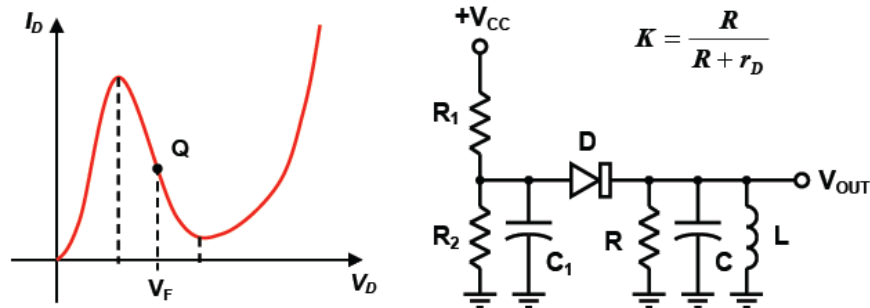
$$f_o = \frac{1}{2\pi\sqrt{LC}}$$



Hartley Oscillator

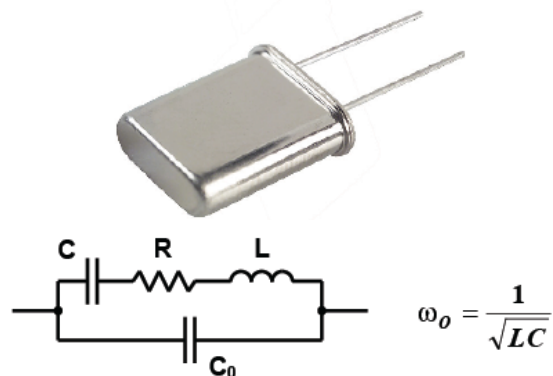


NEGATIVE RESISTANCE OSCILLATOR

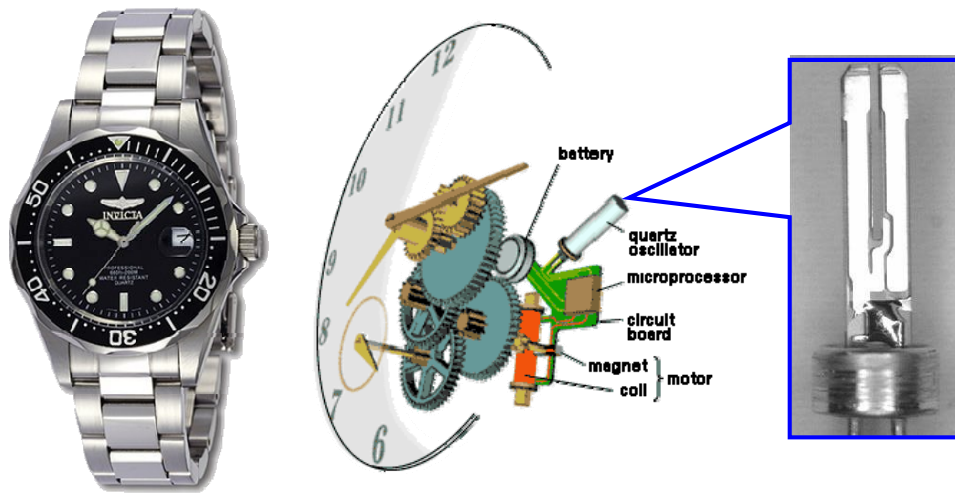


Upto GHz

QUARTZ RESONATOR

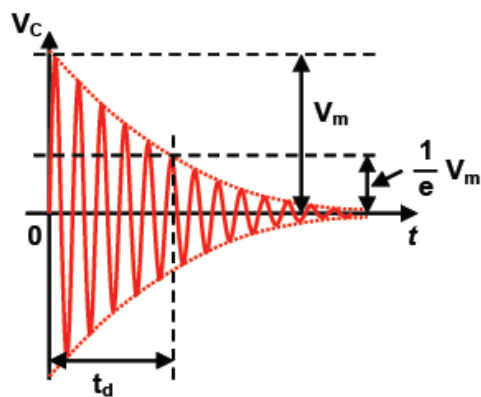


QUARTZ TUNING FORK



32768Hz

Q FACTOR – ЧАНКАА



$$Q \approx \frac{\omega_o}{\Delta\omega} \Rightarrow \Delta\omega \approx \omega_o \frac{1}{Q}$$

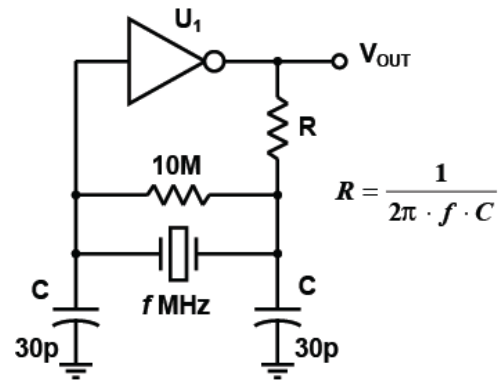
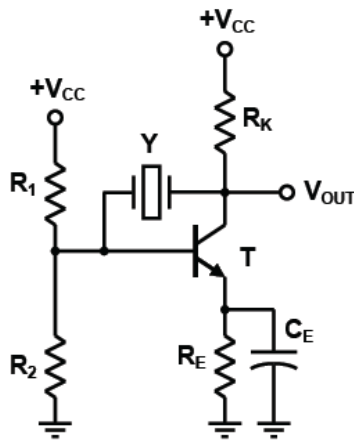
$$Q = 2\pi \frac{E_s}{E_D}$$

E_D – Dissipation energy
 E_s – Stored energy

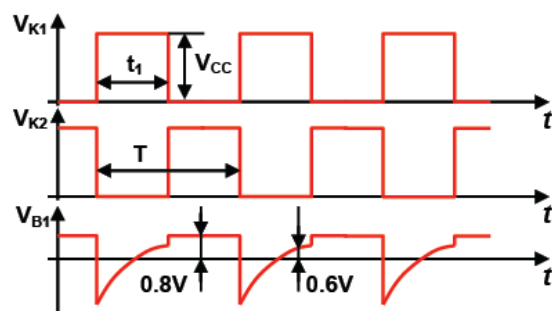
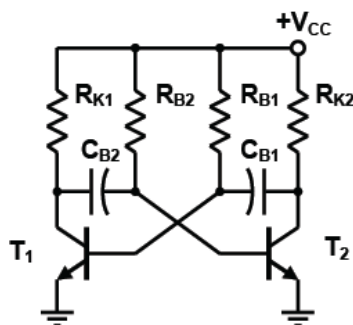
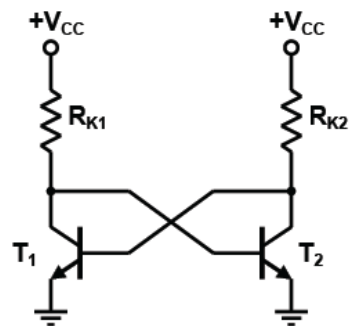
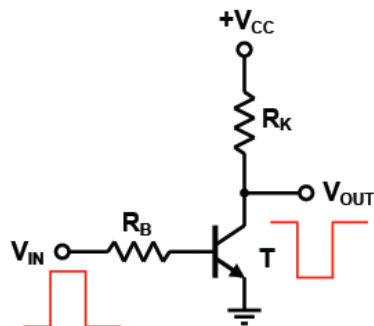
$$\Delta\omega \approx \frac{1}{\pi \cdot t_d} \Rightarrow Q \approx \omega_o \pi \cdot t_d$$

$$\tau = RC \approx 10^{-14} \text{ sec} ; \quad Q_{MAX} = \frac{1}{\omega_o \tau}$$

QUARTZ OSCILLATOR CIRCUITS

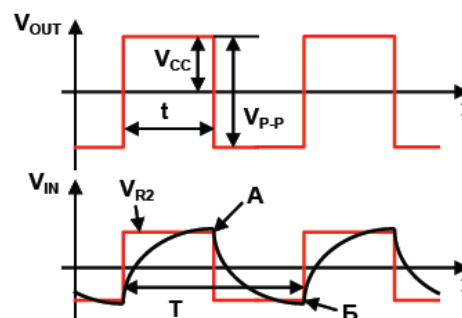
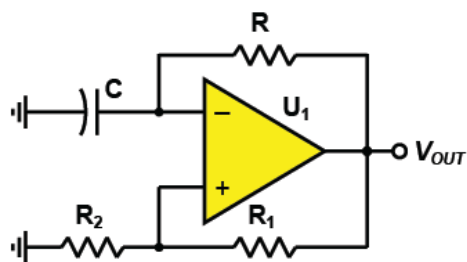


MULTIVIBRATOR ON TRANSISTORS



$$f = \frac{1}{T} = \frac{1}{0.7(\tau_1 + \tau_2)}$$

MULTIVIBRATOR ON OP-AM

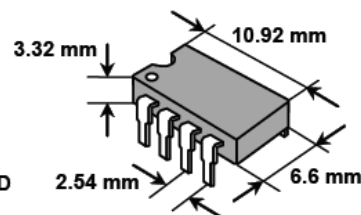
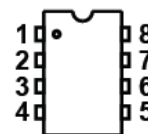
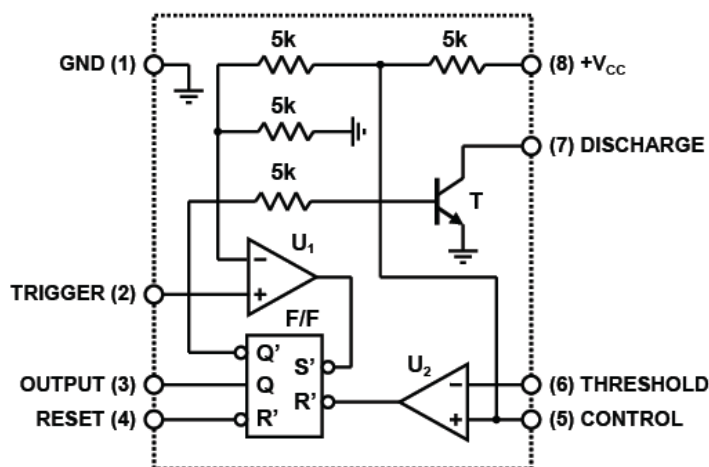


$$V_C = V_{CC}(1 - e^{-t/RC}); \quad V_{R2} = \frac{R_2}{R_1 + R_2} \cdot V_{P-P} = \frac{R_2}{R_1 + R_2} \cdot 2V_{CC}$$

$$1 - e^{-t/RC} = \frac{2R_2}{R_1 + R_2} \Rightarrow t = RC \cdot \ln \left(\frac{R_1 + R_2}{R_1 - R_2} \right)$$

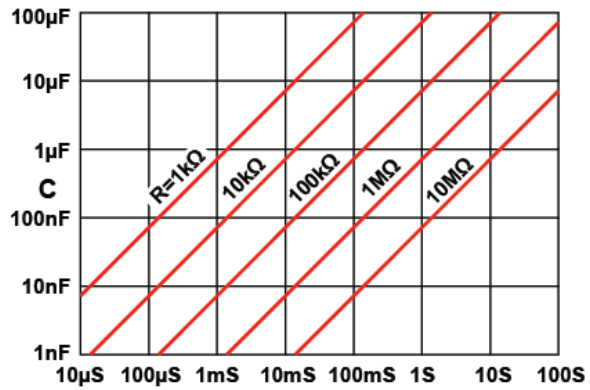
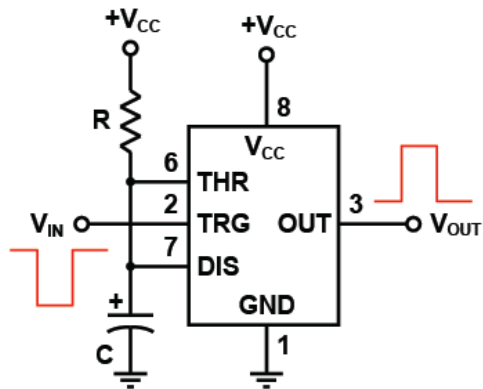
$$f = \frac{1}{T} = \frac{1}{2t}$$

GENERAL PURPOSE OSCILLATOR IC



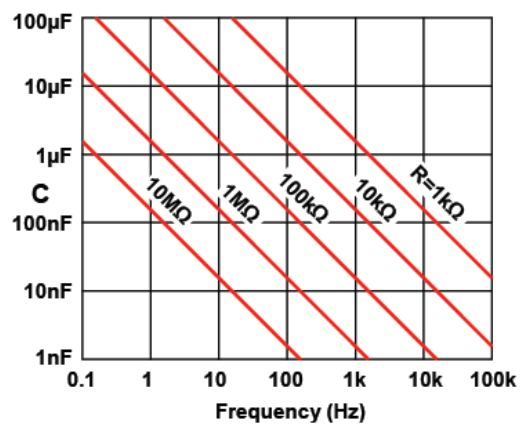
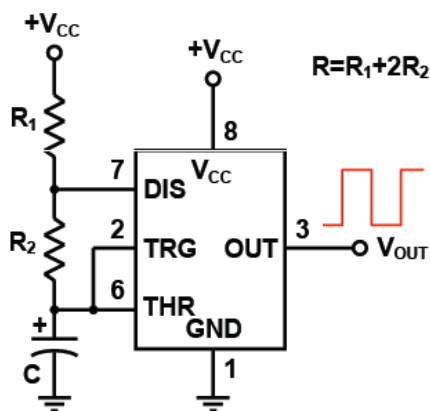
ИНТЕГРАЛ ТАЙМЕР NE555

CIRCUITS ON NE555



ONE SHOT – ХҮЛЭЭХ ВИБРАТОР

CIRCUITS ON NE555



$$t_{ON} = 0.693 \cdot (R_1 + R_2) \cdot C ; \quad t_{OFF} = 0.693 \cdot R_2 \cdot C$$

MULTIVIBRATOR



Thank You !