İkinci Derece Yüksek Geçirgen Filtre:

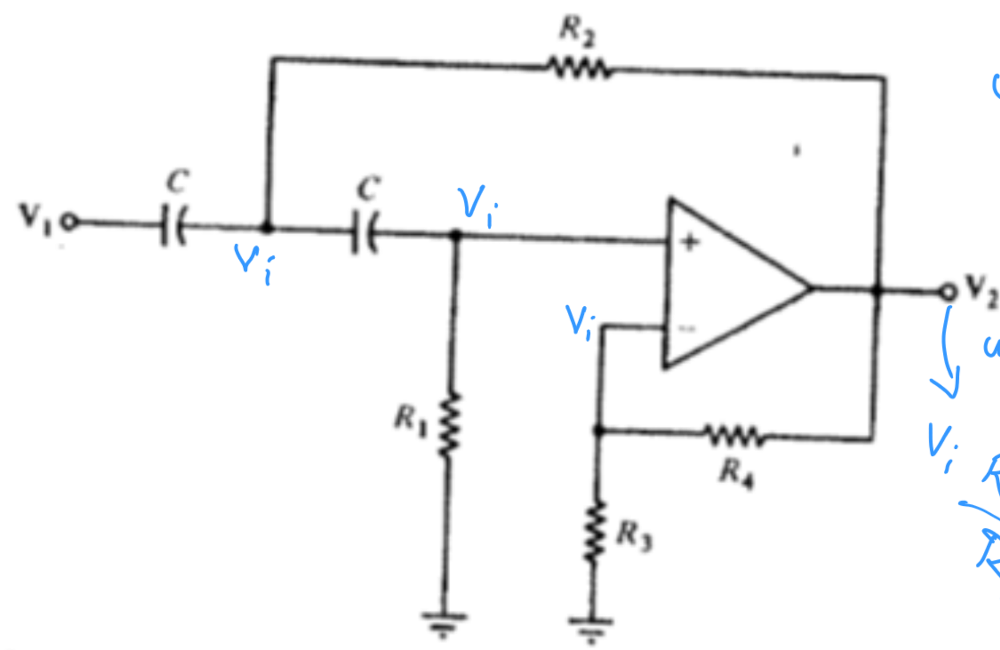


FIGURE 6.4 Second-order VCVS high-pass filter circuit.

$\omega \to 0$: C açık devre

$V_o \to 0$

$\omega \to \infty$: C kısa devre

$V_o \to V_i \dfrac{R_3+R_4}{R_3}$

$V_i \dfrac{R_3+R_4}{R_3}$

$$H(j\omega) = \frac{-\omega^2 C_1 C_2 R_1 R_2}{1 + j\omega R_2 (C_1 + C_2) - \omega^2 C_1 C_2 R_1 R_2} \times \frac{R_4+R_3}{R_3}$$

$j\omega \to s$

$$H(s) = \frac{s^2 C_1 C_2 R_1 R_2}{1 + s R_2 (C_1 + C_2) + s^2 C_1 C_2 R_1 R_2} \times \frac{R_4 \times R_3}{R_3}$$

$$\boxed{H(s) = \frac{s^2}{s^2 + s \frac{1}{R_1}\left(\frac{1}{C_1} + \frac{1}{C_2}\right) + \frac{1}{C_1 C_2 R_1 R_2}} \times \frac{R_4+R_3}{R_3}}$$

Genel form : $\dfrac{K s^2}{s^2 + a\omega_c s + b\omega_c^2}$

$\rightarrow b\omega_c^2 = \dfrac{1}{C_1 C_2 R_1 R_2}$ $\qquad a\omega_c = \dfrac{1}{R_1}\left(\dfrac{1}{C_1} + \dfrac{1}{C_2}\right)$

Butterworth Katsayıları

n	a	b
1	-	1
2	1.414214	1
3	1.000000 -	1 1
4	0.765367 1.847759	1 1
5	- → 1. d 0.618 → 2. d. 1.618 → 2. d.	1 1 1
6		
7		
8		

3. derece ≡ 2. derece → 1. derece

Tasarım problemi:

BPF tasarla f_1, f_2 frekanslar Kazanç = 10

5. derece

→ 5. derece LPF $(2\pi f_2)$ → 5. derece HPF $(2\pi f_1)$ →

///

→ 2. derece LPF $(2\pi f_2)$ → 2. derece LPF $(2\pi f_2)$ → 1. derece LPF $(2\pi f_2)$ →

a = 0.618, b = 1 | a = 1.618, b = 1 | b = 1

→ 2. derece HPF $(2\pi f_1)$ → 2. derece HPF $(2\pi f_1)$ → 1. derece HPF $(2\pi f_1)$ →

2. deree LPF

$1 \leftarrow b w_c^2 = \frac{1}{C_1 C_2 R_1 R_2}$

$0.618 \leftarrow a w_c = \frac{1}{C_1}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$

R_1, R_2 değer ver sonra C_1, C_2'yi bul.

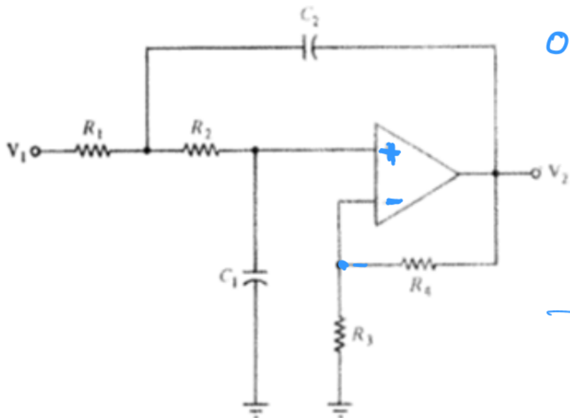


FIGURE 5.12 Second-order VCVS low-pass filter circuit.

2. deree LPF

$1 \leftarrow b$ aynı denklemler

$1.618 \leftarrow a$

1 deree LPF

$1 \leftarrow b$ $\frac{1}{RC} = w_c$

aynı şey HPF için de yaplır

→ HPF

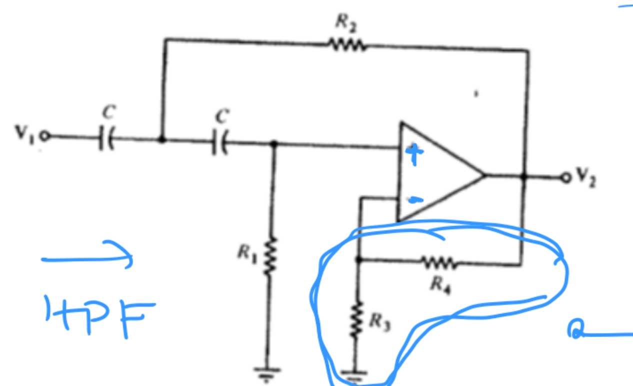
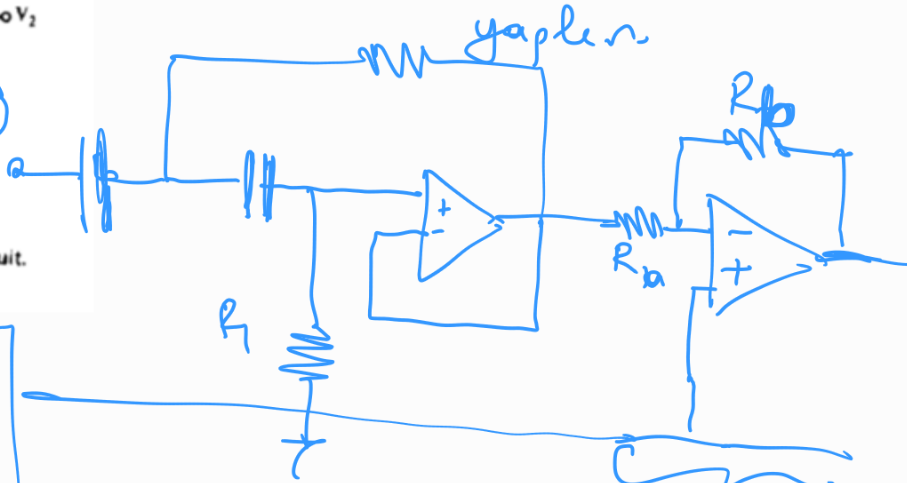


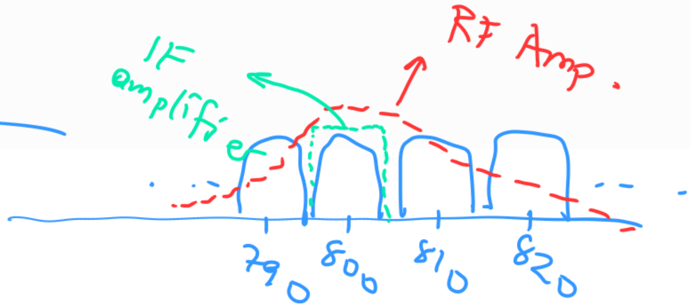
FIGURE 6.4 Second-order VCVS high-pass filter circuit.

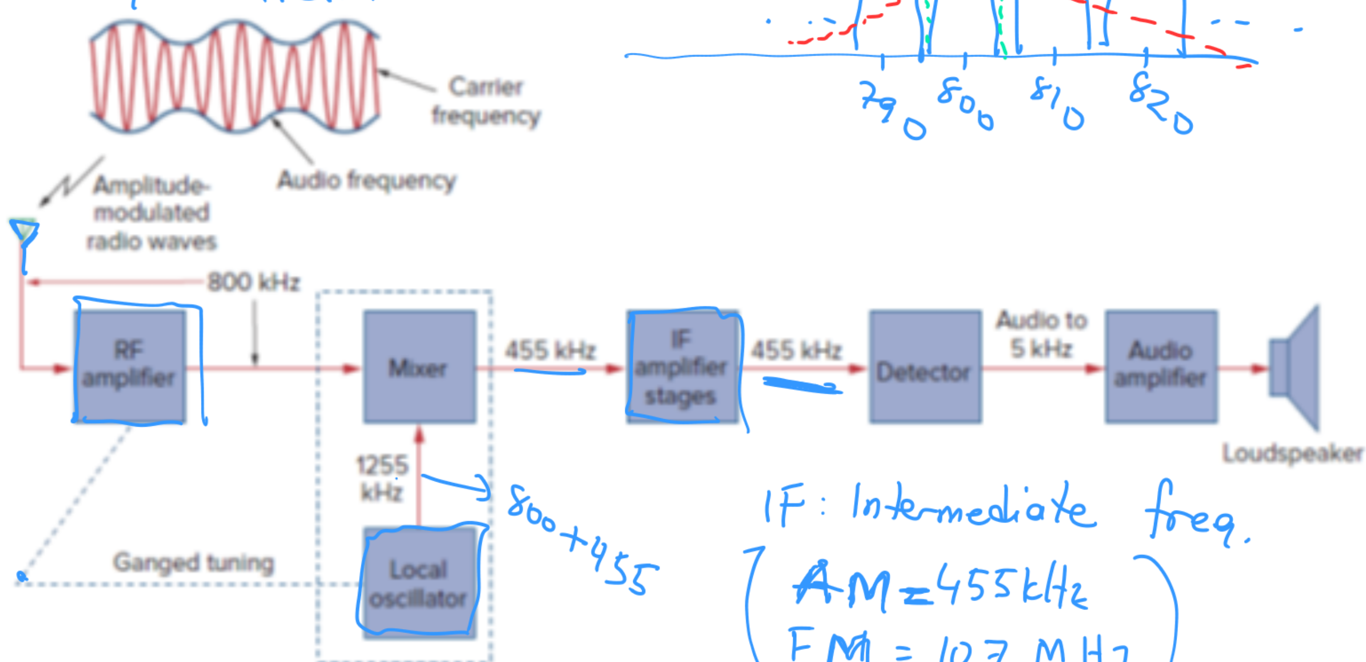


+ ve − uçlara dikkat

UYGULAMALAR

Radyo Alıcısı





800+455

IF: Intermediate freq.

AM = 455 kHz

FM = 10.7 MHz.

Tuner : Bir filtrenin merkez frekansı ve bir osilatörün frekansını ayarlar.

Mixer: Cos ile çarpar.

800 kHz × 1255 kHz $\xrightarrow{\text{mixer}}$ 2055 kHz ve 455

Neyi dinlemek istiyorsam, onu 455'e kaydırıyorum

Example 14.17

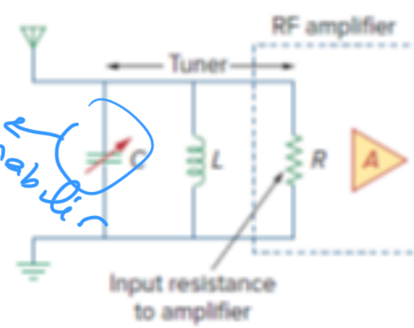
The resonant or tuner circuit of an AM radio is portrayed in Fig. 14.63. Given that $L = 1\ \mu$H, what must be the range of C to have the resonant frequency adjustable from one end of the AM band to another?

Solution:

The frequency range for AM broadcasting is 540 to 1,600 kHz. We consider the low and high ends of the band. Since the resonant circuit in Fig. 14.63 is a parallel type, we apply the ideas in Section 14.6. From Eq. (14.44),

$$\omega_0 = 2\pi f_0 = \frac{1}{\sqrt{LC}}$$

or



ayarlanabilir C.

Figure 14.63 The tuner circuit for Example 14.17.

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

AM

540 — 1600 kHz

$$2\pi\, 540000 \leq \frac{1}{\sqrt{LC}} \leq 2\pi\, 1600000$$

$$4\pi^2\, 540{,}000^2 \le \frac{1}{LC} \le 1600000^2\, 4\pi^2$$

$$4\pi^2\, 540^2 \le \frac{1}{C} \le 1600^2\, 4\pi^2$$

$$\underbrace{\frac{1}{4\pi^2\, 540^2}}_{86.9nF} \geq C \geq \underbrace{\frac{1}{1600^2\, 4\pi^2}}_{9.9nF}$$

Problem 14.17

FM : 88 - 108 MHz

L = 4μH   ayarlanabilir C'nin aralığı ?

0.543 pF — 0.818 pF

Tuşlu Telefon:

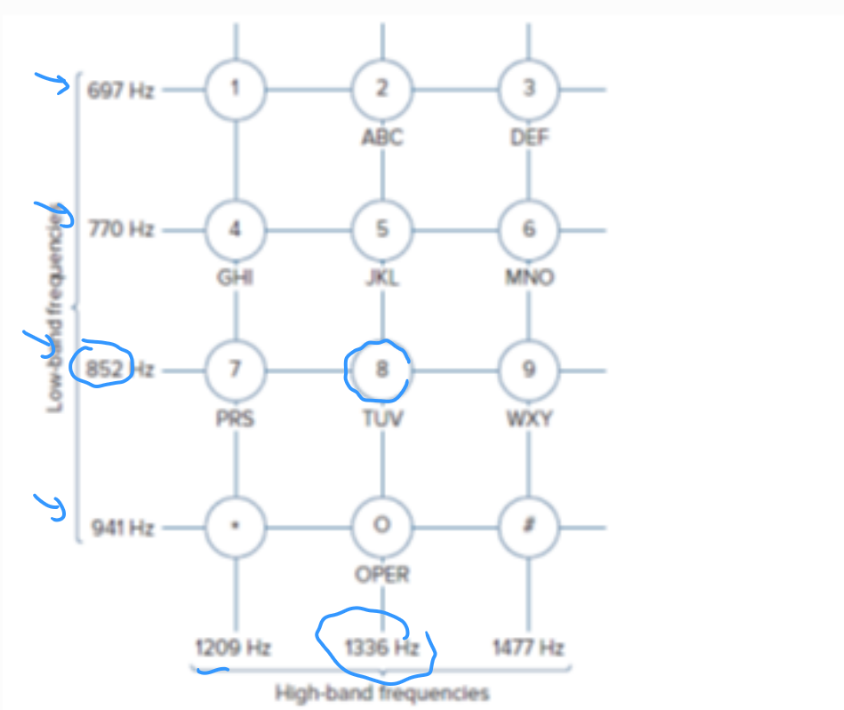
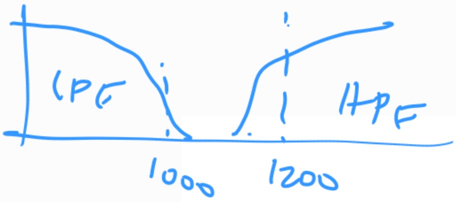


Figure 14.64 → Telefon



852+1336

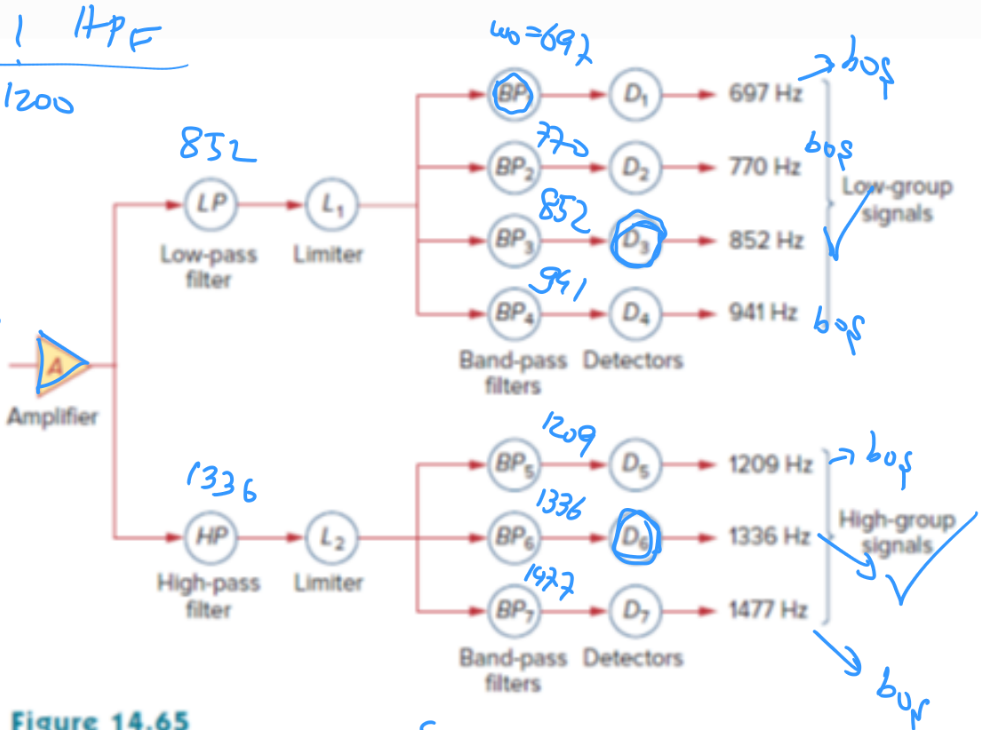


Figure 14.65
Block diagram of detection scheme.

Santral

CHAPTER 15: LAPLACE DÖNÜŞÜMÜ ile DEVRE ANALİZİ

15.1. Giriş

Sistem: Bir fiziksel işlemin girdileri ve çıktıları arasındaki ilişkinin matematiksel modeli.

Devreler de bir sistemdir.

Devre analizi (R, L, C)

→ Sinüs girdili yatışkın durum → Fazör.

→ Diğer durumlar → Laplace (başlangıç koşulları da işin içine giren)

15.2 LAPLACE Dönüşümü

$$\underbrace{\mathcal{L}[f(t)]}_{\text{zaman alanı}} \longrightarrow \underbrace{F(s)}_{\text{frekans alanı}} = \int_{0^-}^{\infty} f(t)\,e^{-st}\,dt$$

→ Tek taraflı

- İki taraflı da var $\int_{-\infty}^{\infty}$, ancak tek taraflı yeterli.
- $s=\sigma+j\omega$ (kompleks)
- Ters dönüşüm karışık. Ancak bizim için $F(s)$ her zaman iki polinomun bölümü; işimizi tablolarla halledeceğiz.

$$F(s) \xrightarrow{\mathcal{L}^{-1}} f(t)$$

Exemple 15.1

a) $u(t) \xrightarrow{\mathcal{L}} \int_{0}^{\infty} u(t)e^{-st}dt = \int_{0}^{\infty} e^{-st}dt$

$$= -\frac{e^{-st}}{s}\Big|_{0}^{\infty} = \frac{1}{s}$$

b) $e^{-at}u(t) \xrightarrow{\mathcal{L}} \int_0^\infty e^{-at}u(t)e^{-st}\,dt$

$$= \int_0^\infty u(t)\, e^{-(s+a)t}\,dt$$

$$= \frac{1}{s+a}$$

c) $\delta(t) \xrightarrow{\mathcal{L}} ?$ $\quad \int_{0^-}^{\infty} \underbrace{\delta(t)}_{\text{sadeee } t=0\text{'da değer alıyor}} e^{-st}\,dt$

$$\int_{0^-}^{0^+} \delta(t) \underbrace{e^{-st}}_{1}\,dt$$

$$= \int_{0^-}^{0^+} \delta(t)\,dt = 1$$

Example 15.2

$f(t) = \sin(\omega t)$

$$F(s) = \int_{0^-}^{\infty} \underbrace{\sin(\omega t)}_{\frac{e^{j\omega t} - e^{-j\omega t}}{2j}} e^{-st}\,dt = \int_{0^-}^{\infty} \frac{e^{-(s-j\omega)t} - e^{-(s+j\omega)t}}{2j}\,dt$$

$$= \frac{1}{2j}\left[\frac{1}{s-j\omega} - \frac{1}{s+j\omega}\right]$$

$$= \frac{1}{2j}\left[\frac{\cancel{s}+j\omega-\cancel{s}+j\omega}{s^2+\omega^2}\right]$$

$$F(s) = \frac{\omega}{s^2+\omega^2}$$

$$\sin(\omega t) \xrightarrow{\mathcal{L}} \frac{\omega}{s^2+\omega^2}$$

$f(t) = \cos(\omega t)$ $\qquad F(s) = ?$

$$\int_{0^-}^{\infty} \cos(\omega t) e^{-st}\, dt = \int_{0^-}^{\infty} \frac{e^{j\omega t} + e^{-j\omega t}}{2} e^{-st}\, dt$$

$$= \int_{0^-}^{\infty} \frac{e^{-(s-j\omega)t} + e^{-(s+j\omega)t}}{2}\, dt$$

$$= \frac{1}{2}\left[\frac{1}{s-j\omega} + \frac{1}{s+j\omega}\right]$$

$$= \frac{1}{2}\,\frac{s+j\omega+s-j\omega}{s^2+\omega^2} = \frac{s}{s^2+\omega^2}$$

Problem 15.2

$$f(t) = 15\cos(3t) \overset{\mathcal{L}}{\Rightarrow} 15\,\frac{s}{s^2+9}$$

TABLE 15.1

Properties of the Laplace transform.

Property	$f(t)$	$F(s)$
Linearity	$a_1f_1(t) + a_2f_2(t)$	$a_1F_1(s) + a_2F_2(s)$
Scaling	$f(at)$	$\frac{1}{a}F\left(\frac{s}{a}\right)$
Time shift	$f(t-a)u(t-a)$	$e^{-as}F(s)$
Frequency shift	$e^{-at}f(t)$	$F(s+a)$
Time differentiation	$\frac{df}{dt}$	$sF(s) - f(0^-)$
	$\frac{d^2f}{dt^2}$	$s^2F(s) - sf(0^-) - f'(0^-)$
	$\frac{d^3f}{dt^3}$	$s^3F(s) - s^2f(0^-) - sf'(0^-) - f''(0^-)$
	$\frac{d^nf}{dt^n}$	$s^nF(s) - s^{n-1}f(0^-) - s^{n-2}f'(0^-) - \cdots - f^{(n-1)}(0^-)$
Time integration	$\int_0^t f(x)dx$	$\frac{1}{s}F(s)$
Frequency differentiation	$tf(t)$	$-\frac{d}{ds}F(s)$
Frequency integration	$\frac{f(t)}{t}$	$\int_s^\infty F(s)ds$
Time periodicity	$f(t) = f(t+nT)$	$\frac{F_1(s)}{1-e^{-sT}}$
Initial value	$f(0)$	$\lim_{s\to\infty} sF(s)$
Final value	$f(\infty)$	$\lim_{s\to 0} sF(s)$
Convolution	$f_1(t) * f_2(t)$	$F_1(s)F_2(s)$

Evrişim

TABLE 15.2

Laplace transform pairs.*

$f(t)$	$F(s)$
$\delta(t)$	1
$u(t)$	$\frac{1}{s}$
e^{-at}	$\frac{1}{s+a}$
t	$\frac{1}{s^2}$
t^n t^n	$\frac{n!}{s^{n+1}}$
te^{-at}	$\frac{1}{(s+a)^2}$
t^ne^{-at}	$\frac{n!}{(s+a)^{n+1}}$
$\sin \omega t$	$\frac{\omega}{s^2+\omega^2}$
$\cos \omega t$	$\frac{s}{s^2+\omega^2}$
$\sin(\omega t + \theta)$	$\frac{s\sin\theta + \omega\cos\theta}{s^2+\omega^2}$
$\cos(\omega t + \theta)$	$\frac{s\cos\theta - \omega\sin\theta}{s^2+\omega^2}$
$e^{-at}\sin \omega t$	$\frac{\omega}{(s+a)^2+\omega^2}$
$e^{-at}\cos \omega t$	$\frac{s+a}{(s+a)^2+\omega^2}$

*Defined for $t \geq 0$; $f(t) = 0$, for $t < 0$.

Example 15.3

$$f(t) = \delta(t) + 2u(t) - 3e^{-2t}u(t)$$

$$F(s) = 1 + \frac{2}{s} - \frac{3}{s+2}$$

$$= \frac{s(s+2) + 2(s+2) - 3}{s(s+2)}$$

$$= \frac{s^2+2s+2s+4-3}{s(s+2)} = \frac{s^2+4s+1}{s(s+2)}$$

Problem 15.3

$$f(t) = \left(\cos(2t) + e^{-4t}\right) u(t)$$

$$= \underbrace{\cos(2t)u(t)}_{\cos(2t)} + \underbrace{e^{-4t}\, u(t)}$$

$$F(s) = \frac{s}{s^2+4} + \frac{1}{s+4}$$

Example 15.4

$$f(t) = t^2 \sin(2t)\, u(t)$$

$$\sin(2t) \xrightarrow{\mathcal{L}} \frac{2}{s^2+4}$$

$$t\sin(2t) \xrightarrow{\mathcal{L}} -\frac{d}{ds}\,\frac{2}{s^2+4}$$

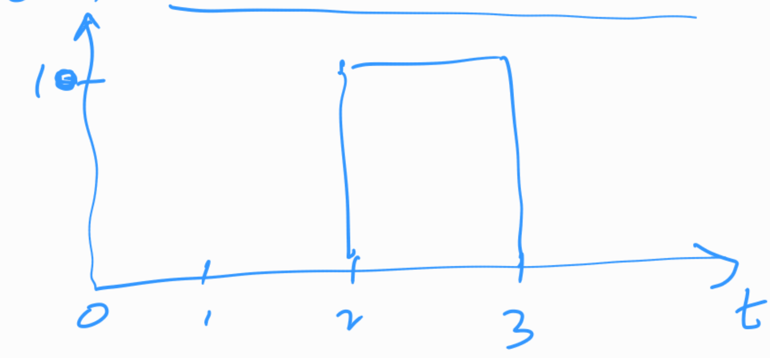
$$= \frac{4s}{(s^2+4)^2}$$

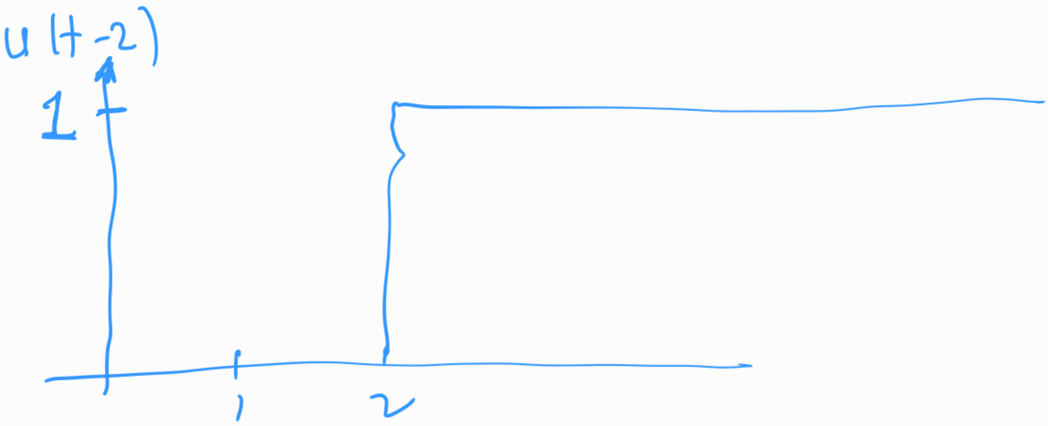
$$t^2 \sin(2t) \xrightarrow{\mathcal{L}} -\frac{d}{ds}\left\{\frac{4s}{(s^2+4)^2}\right\}$$

Example 15.5

$G(s) = ?$

$u(t)$?





$$\boxed{10\big(u(t-2) - u(t-3)\big) = g(t)}$$

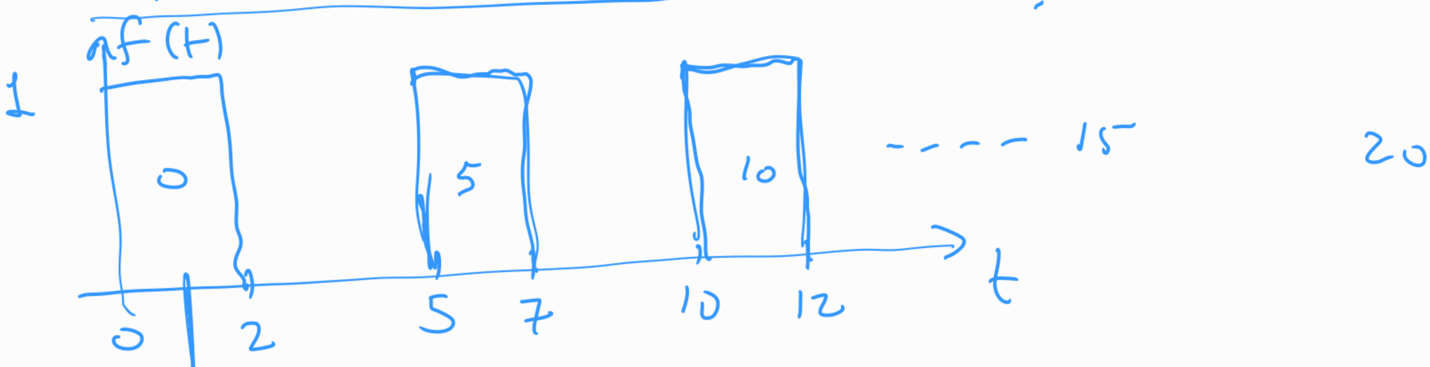
$$\mathcal{L}\{g(t)\} = \mathcal{L}\{u(t-2) - u(t-3)\} \times 10$$

$$= \underbrace{\mathcal{L}\{u(t-2)\}^{\times 10}}_{\frac{e^{-2s}}{s} \times 10} - \underbrace{\mathcal{L}\{u(t-3)\}^{\times 10}}_{\frac{e^{-3s}}{s} \times 10}$$

$$G(s) = \frac{10}{s}\left\{e^{-2s} - e^{-3s}\right\}$$

Problem 15.6

$F(s) = ?$



$$u(t) - u(t-2)$$

$$\downarrow$$

$$\frac{1}{s} - \frac{e^{-2s}}{s}$$

$$F(s) = \frac{(1-e^{-2s})}{s}\left[1 + e^{-5s} + e^{-10s} + e^{-15s} + \cdots\right]$$

$$F(s) = \frac{1-e^{-2s}}{s}\underbrace{\left[\left(e^{-5s}\right)^0 + \left(e^{-5s}\right)^1 + \left(e^{-5s}\right)^2 + \cdots\right]}_{\frac{1}{1-e^{-5s}}}$$

$$F(s) = \frac{1-e^{-2s}}{s\left(1-e^{-5s}\right)}$$

Example 15.7

$$H(s) = \frac{20}{(s+3)(s^2+8s+25)}$$

initial & final values

$$h(0) = \lim_{s\to\infty} sH(s) = \lim_{s\to\infty} \frac{20s}{(s+3)(s^2+8s+25)} = 0$$

$$h(\infty) = \lim_{s\to 0} sH(s) = \lim_{s\to 0} \frac{20s}{(s+3)(s^2+8s+25)} = 0$$

en başta ve en sonda sıfırmış.

$$F(s) \xrightarrow{\mathcal{L}^{-1}} f(t)$$

$F(s)$ bizim için her zaman $\frac{N(s)}{D(s)}$

iki polinomun bölümü

$$F(s) = \frac{N(s)}{(s+p_1)(s+p_2)\cdots(s+p_n)}$$

$$= \frac{A_1}{s+p_1} + \frac{A_2}{s+p_2} + \cdots + \frac{A_n}{s+p_n}$$

$$f(t) = \left(A_1e^{-p_1t} + A_2e^{-p_2t} + \cdots + A_ne^{-p_nt}\right)u(t)$$

Kısmi kesir açılımı yapacağız.