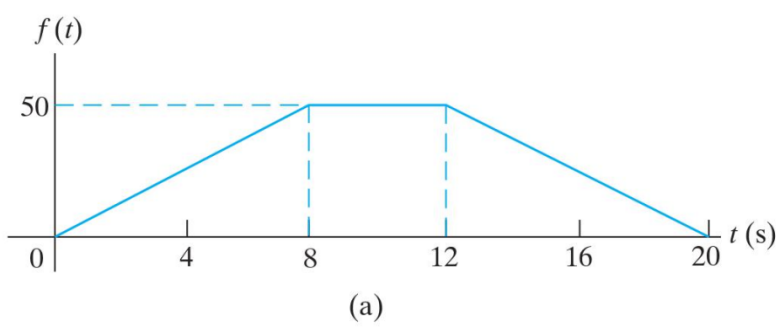
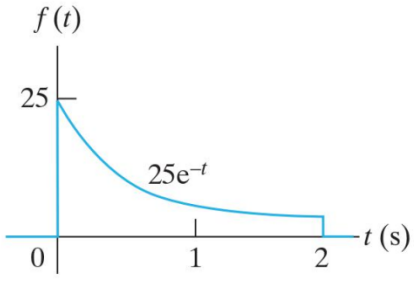
Principles of EE 2- Problem - Final

I. Laplace transform

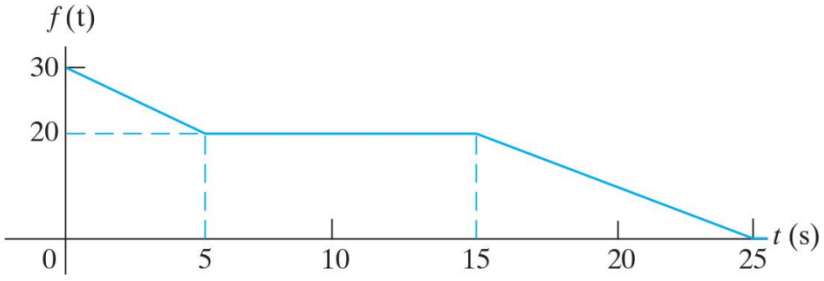
1. Find the Laplace transform of the given function below:



(a)



(b)



(c)

2. Find the inverse Laplace transform of the following function:

a) $F(s) = \dfrac{8s^2 + 37s + 32}{(s+1)(s+2)(s+4)}$;

b) $F(s) = \dfrac{13s^3 + 134s^2 + 392s + 288}{s(s+1)(s^2 + 10s + 24)}$

c) $F(s) = \dfrac{20s^2 + 16s + 12}{(s+1)(s^2 + 2s + 5)}$;

d) $F(s) = \dfrac{250(s+7)(s+14)}{s(s^2 + 14s + 50)}$

e) $F(s) = \dfrac{10s^2 + 28s + 36}{(s+2)(s^2 + 2s + 10)}$;

f) $F(s) = \dfrac{5s^2 + 9s + 4}{s^2(s+4)}$

g) $F(s) = \dfrac{s+4}{s^2 + 6s + 9}$;

h) $F(s) = \dfrac{5s^3 + 20s^2 - 49s - 108}{s^2 + 7s + 10}$

II. Circuit analysis in S-domain

1. The switch in the circuit in the Fig. 1 has been in the position (a) for a long time. At $t = 0$, the switch moves instantaneously to position (b).

   a) Construct and S-domain circuit for $t > 0$.

   b) Find $V(s)$.

   c) Find $V(t)$.

   (You can use: $V_g = 50\text{V}, C = 500\text{nF}, R = 1\text{k}\Omega$)

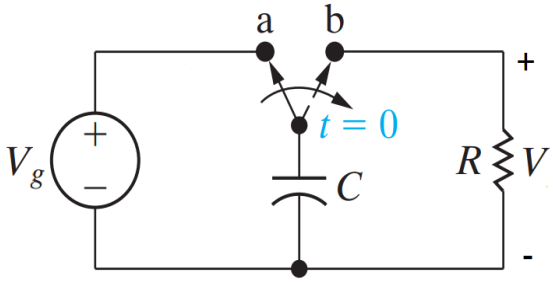


Fig. 1

III. Butterworth filter design

1. Only using 1kΩ resistor, design a circuit that will implement the low pass Butterworth filter in which f_c = 2000Hz. Construct the circuit diagram and label all the component values for each following cases:

Normalized (so that ω_c = 1 rad/s) Butterworth Polynomials up to the Eighth Order

n	*n*th-Order Butterworth Polynomial
1	$(s + 1)$
2	$(s^2 + \sqrt{2}s + 1)$
3	$(s + 1)(s^2 + s + 1)$
4	$(s^2 + 0.765s + 1)(s^2 + 1.848s + 1)$
5	$(s + 1)(s^2 + 0.618s + 1)(s^2 + 1.618s + 1)$
6	$(s^2 + 0.518s + 1)(s^2 + \sqrt{2} + 1)(s^2 + 1.932s + 1)$
7	$(s + 1)(s^2 + 0.445s + 1)(s^2 + 1.247s + 1)(s^2 + 1.802s + 1)$
8	$(s^2 + 0.390s + 1)(s^2 + 1.111s + 1)(s^2 + 1.6663s + 1)(s^2 + 1.962s + 1)$

a) n = 2, Gain of 1.

b) n = 3, Gain of 3.

c) n = 4, Gain of 3.

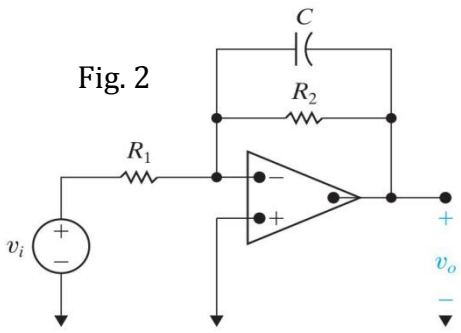
d) n = 2, Gain of 3.

2. Design an Op-amp based HPF with a cut off frequency of 4kHz and pass band gain of 8 using a 250nF capacitor

a) Label the component value in Fig. 2 .

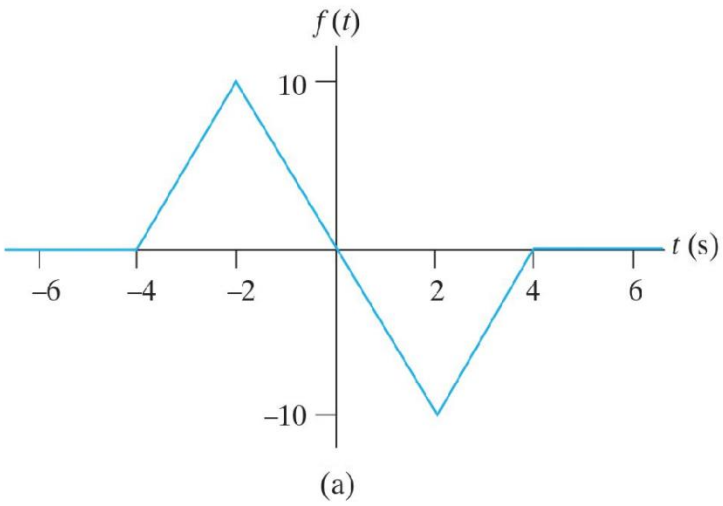
b) If the value of the feedback resistor is changed but the value of the resistor in forward path is unchanged. What characteristic of the filter is changed.

Fig. 2

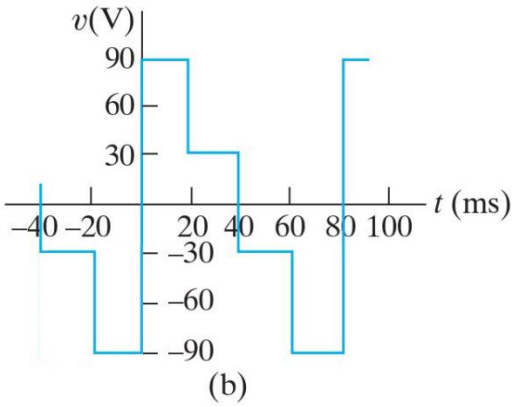


IV. Fourier series

1. Find the Fourier series of the function below:



(a)



(b)