EEE203 Assignment 2

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Deadline: 23:55 2018/12/19

1 Fourier Transform 2 mark

Find the Fourier transform of each of the following signals and sketch the magnitude and phase as a function of frequency, including both positive and negative frequencies.

(a) $\delta(t-5)$

(b) $e^{-at}u(t)$, a is real and positive

2 Fourier Transform 2 mark

Let $X(j\omega)$ be the Fourier Transform of

$$x(t) = \frac{b}{t^2 + b}$$

where b is a positive real value.

Calculate

$$\int_{-\infty}^{+\infty} \omega X(j\omega) d\omega$$

3 Laplace Transform 2 mark

An LTI system has an impulse response $h(t)$ for which the Laplace transform $H(s)$ is

$$H(s) = \int_{-\infty}^{+\infty} h(t)e^{-st}dt = \frac{1}{s+1}, \quad Re\{s\} > -1$$

Determine the system output $y(t)$ for all t if the input $x(t)$ is given by

$$x(t) = e^{-t/2} + 2e^{-t/3} \quad \text{for all} \quad t.$$

4 Laplace Transform for Differential Equations 2 mark

Solve the following initial-value differential equations using the Laplace transform method:

1. $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 4y(t) = u(t); \quad y(0^-) = \dot{y}(0^-) = 0$
2. $\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 8y(t) = te^{-3t}u(t); \quad y(0^-) = \dot{y}(0^-) = 1$

5 Fourier series 2 mark

In order to achieve synchronization between the modulating and demodulating carriers, a special circuit referred to as a phase-locked loop (PLL) is commonly used in communications. The block diagram representing the PLL is shown in the following figure.

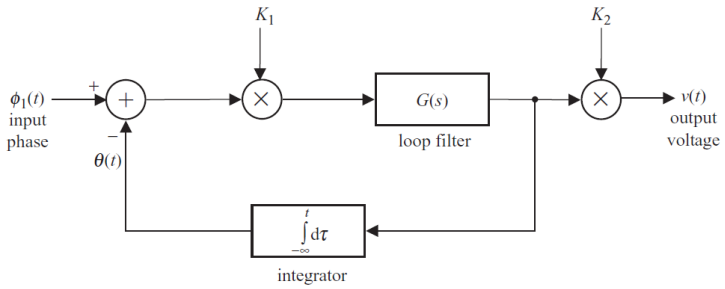

Figure 1: Block diagram of a phase-locked loop

where K_1 and K_2 are gain constants and $G(s)$ is the transfer function of a loop filter.

1. Find the transfer function of the PLL.
2. Specify the condition under which the PLL acts as an ideal differentiator. In other words, derive the expression for $G(s)$ when the transfer function of the PLL equals Ks, with K being a constant.