

### 3.9 Time Response of ODEs

For the given system  $G(s) = \frac{5}{s+7}$ :

- What are the poles, zeros, and DC gain?
- What is the general form of the free response?

If any poles are complex then express the free/forced response in its “real” form.

**Solution :**

**Poles:**  $s = -7$

**Zeros:** No zeros

**DC Gain:**  $G(0) = \frac{5}{7}$

**Free response:**  $y(t) = Ce^{-7t}$

**Forced response:**  $y_p(t)$  depends on  $u(t)$

**GPT Answer:**

- **Poles:**  $s = -7$
- **Zeros:** None
- **DC Gain:**  $\frac{5}{7}$
- **Free Response:**  $y(t) = Ke^{-7t}$
- **Forced Response:** Mirrors the form of the input, with specifics determined by  $G(s)$ .

**Confidence Level: 100%**

**Correct**

**Claude Answer:**

Let's analyze the given system  $G(s) = \frac{5}{s+7}$  and answer the questions one by one:

**1. Poles, zeros, and DC gain:**

- **Poles:** The denominator of the transfer function is  $s + 7$ . Setting this equal to zero, we get  $s = -7$ . Therefore, the system has a single pole at  $s = -7$ .
- **Zeros:** There are no zeros in this system because the numerator is a constant (5).

- **DC gain:** The DC gain is the value of the transfer function when  $s = 0$ . Substituting  $s = 0$ , we get:

$$G(0) = \frac{5}{0 + 7} = \frac{5}{7}$$

So, the DC gain is  $\frac{5}{7}$ .

2. **General form of the free response:** The pole is real and located at  $s = -7$ . The general form of the free response for a system with a single real pole is:

$$y(t) = K e^{-7t}$$

where  $K$  is a constant determined by the initial conditions.

3. **General form of the forced response:** The forced response depends on the input signal. In general, for a stable system with a single real pole, the forced response will consist of a particular solution that depends on the input signal and a transient term that decays exponentially with time. The transient term will have the same form as the free response.

Since the pole is real, there is no need to express the free or forced response in its "real" form, as it is already in real form.

**Confidence Level: 95%**

**Correct**