



1. **Identify the components** of the system shown in the diagram above. List them in the table below.

Component	Function

QUESTION

The diagram below shows a control system for a motor. The system is designed to maintain a constant speed of the motor despite changes in the load.

The transfer function of the controller is given by:

$$K(s) = \frac{K}{s + a}$$
 where K and a are constants.

The transfer function of the motor is given by:

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

The feedback block is given by:

$$H(s) = 1$$

The closed-loop transfer function is given by:

$$T(s) = \frac{K(s)M(s)}{1 + K(s)M(s)H(s)}$$

The system is initially at rest. At $t = 0$, a step input of magnitude 1 is applied to the reference input.

(a) Determine the closed-loop transfer function $T(s)$.

(b) Determine the steady-state value of the motor speed $\omega(s)$.

(c) Determine the time constant of the system.

(d) Determine the damping ratio of the system.

(e) Determine the natural frequency of the system.

(f) Determine the overshoot of the system.

(g) Determine the settling time of the system.

(h) Determine the rise time of the system.

(i) Determine the peak time of the system.

(j) Determine the peak value of the motor speed.

(k) Determine the time to reach the peak value.

(l) Determine the time to reach 90% of the steady-state value.

(m) Determine the time to reach 95% of the steady-state value.

(n) Determine the time to reach 99% of the steady-state value.

(o) Determine the time to reach 99.9% of the steady-state value.

(p) Determine the time to reach 99.99% of the steady-state value.

(q) Determine the time to reach 99.999% of the steady-state value.

(r) Determine the time to reach 99.9999% of the steady-state value.

(s) Determine the time to reach 99.99999% of the steady-state value.

(t) Determine the time to reach 99.999999% of the steady-state value.

(u) Determine the time to reach 99.9999999% of the steady-state value.

(v) Determine the time to reach 99.99999999% of the steady-state value.

(w) Determine the time to reach 99.999999999% of the steady-state value.

(x) Determine the time to reach 99.9999999999% of the steady-state value.

(y) Determine the time to reach 99.99999999999% of the steady-state value.

(z) Determine the time to reach 99.999999999999% of the steady-state value.