A 1st order system has the transfer function, \( H(s) = \frac{100}{(s + 2)} \).

1. What is the time constant \( \tau \) for this system?

Suppose we controlled this system using the strategy shown below.

2. What is the name of this type of control approach?

3. What is the closed loop transfer function for this system?

4. Suppose we have a unit step function input, i.e. \( x_i(t) = H(t) \). What value of \( K \) will result in a steady state error of 5\%, i.e. \( x_i(\infty) - x_o(\infty) = 0.05 \) ?

5. For the step function input what are the location(s) of the pole(s) of \( X_o(s) \) and is the system stable?

6. What is the time constant for the closed loop system?

7. How would you change the block diagram given above if you wanted to use integral control?

8. What would be the advantage of integral control in this application?

**ANSWERS**

<table>
<thead>
<tr>
<th>( f(t) )</th>
<th>( F(s) )</th>
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</thead>
<tbody>
<tr>
<td>( H(t) )</td>
<td>( \frac{1}{s} )</td>
</tr>
<tr>
<td>( e^{-at} )</td>
<td>( \frac{1}{s+a} )</td>
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</table>
(1) 1. \( r = 2 \)  

(1) 2. Proportionality  

(1) 3. \( T(s) = \frac{100K}{s+2(1+100K)} = \frac{100K}{s+2+100K} \)

4. \( x_0(\infty) = \lim_{s \rightarrow 0} s \tilde{x}_0(s) \)

where \( \tilde{x}_0(s) = \frac{1}{s} \frac{100K}{s+2+100K} \)

\[ x_0(\infty) = \frac{100K}{2+100K} = x_i(\infty) = 0.05 = 0.95 \]

\[ 100K = 1.9 + 95K \quad \rightarrow \quad 5K = 1.9 \]

\[ K = 0.38 \approx 0.4 \]

(3) 5. Poles at \( s = 0 \)  

\[ s = -(2+100K) \]

Yes, system is stable.

(1) 6. Time constant = \( \frac{1}{2+100K} \)

(1) 7. Replace \( K \) with \( \frac{K}{S} \)

(1) 8. Zero steady state error.