# Problem 5.5

Show that the negative-feedback system shown in Fig.2.5(b) is BIBO stable if and only if the gain $a$ has a magnitude less than 1. For $a = 1$, find a bounded input $r(t)$ that will excite an unbounded output.

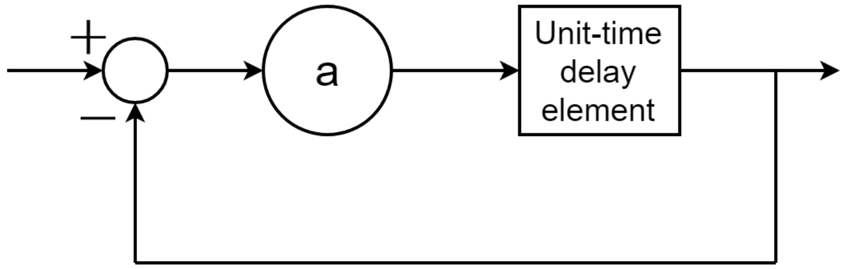


**Fig. 1**: Fig.2.5(b)

# Problem 5.10

Is the homogeneous state equation

$$\dot{\boldsymbol{x}} = \begin{bmatrix} -1 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \boldsymbol{x}$$

marginally stable? Asymptotically stable?

# Problem 5.13

Is the discrete-time homogeneous state equation

$$\boldsymbol{x}[k+1] = \begin{bmatrix} 0.9 & 0 & 1 \\ 0 & 1 & 1 \\ 0 & 0 & 1 \end{bmatrix} \boldsymbol{x}[k]$$

marginally stable? Asymptotically stable?

# Problem 5.22

Show that the equation in Problem 5.21

$$\dot{x} = 2tx + u \qquad y = e^{-t^2}x$$

can be transformed by using $\bar{x} = P(t)x$, with $P(t) = e^{-t^2}$,into

$$\dot{\bar{x}} = 0 \cdot \bar{x} + e^{-t^2}u \qquad y = \bar{x}$$

Is the equation BIBO stable? Marginally stable? Asymptotically stable? Is the transformation a Lyapunov transformation?

# Problem 5.23

Is the homogeneous equation

$$\dot{\boldsymbol{x}} = \begin{bmatrix} -1 & 0 \\ -e^{-3t} & 0 \end{bmatrix} \boldsymbol{x}$$

for $t_0 \geq 0$, marginally stable? Asymtotically stable?