b) cntd.

find $\frac{\theta(s)}{r(s)} = \dfrac{\dfrac{(K_p + \frac{K_i}{s}) \cdot b}{s^2 + bK_d s - a}}{1 + \dfrac{(K_p + \frac{K_i}{s}) \cdot b}{s^2 + bK_d s - a}}$

$$= \frac{bK_p + b\frac{K_i}{s}}{s^2 + bK_d s - a + bK_p + b\frac{K_i}{s}} = \frac{bK_p s + bK_i}{s^3 + bK_d s^2 + (bK_p - a)s + bK_i}$$

$$\boxed{\frac{\theta(s)}{r(s)} = \frac{bK_p s + bK_i}{s^3 + bK_d s^2 + (bK_p - a)s + bK_i}}$$

the poles of this transfer function are the same as the poles from part a)

c) Routh Array

s^3	1	$bK_p - a$
s^2	bK_d	bK_i
s^1	$bK_p - a - \frac{K_i}{K_d}$	0
s^0	bK_i	

Stability Criteria

$bK_d > 0$

$\boxed{K_d > 0}$

$bK_i > 0$

$\boxed{K_i > 0}$

$bK_p - a - \frac{K_i}{K_d} > 0$

$bK_p > \frac{K_i}{K_d} + a$

For $-18.52 \leq a \leq 18.52$ and $b = 7.2$

harder criterion $\rightarrow$ $\boxed{7.2 K_p > \frac{K_i}{K_d} + 18.52}$ ✓

or $7.2 K_p > \frac{K_i}{K_d} - 18.52$ X

$$\boxed{\begin{aligned} K_i &= 1.5 \\ K_d &= 1.5 \\ K_p &= 5 \end{aligned}} \left(> \frac{1 + 18.52}{7.2} = 2.7 \right)$$