(b)

$$(j\omega)^3 + 8(j\omega)^2 + 32(j\omega) + K = 0$$

$$\underbrace{(-8\omega^2 + K)} + j\,\underbrace{(-\omega^3 + 32\omega)} = 0$$

$$\omega(\omega^2 - 32) = 0$$

$$\omega = \pm\sqrt{32}$$

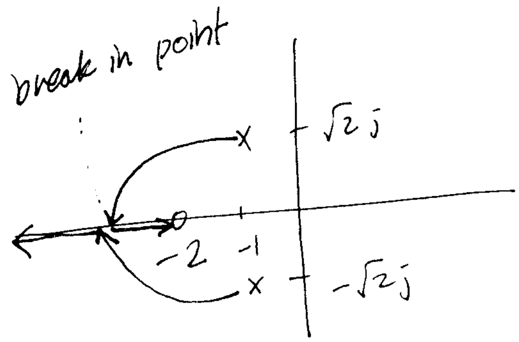
$$K = 8\omega^2 = 8 \cdot 32$$

$$= \underline{\underline{256}}$$

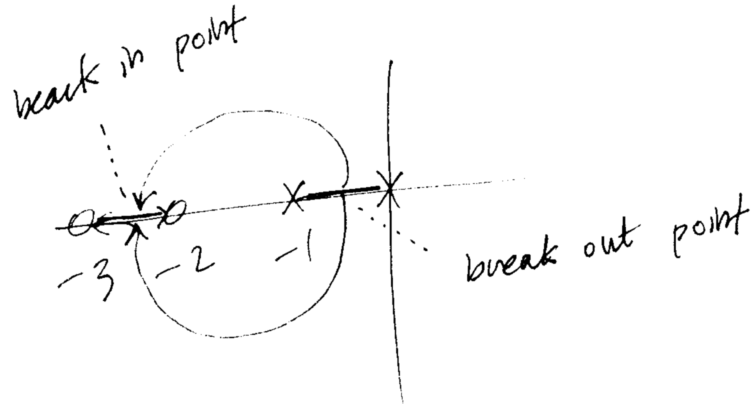
STEP 6 Find the breakaway & break-in points.

motivation. $G(s) = \dfrac{s+2}{s^2+2s+3}$

```
num = [1 2];
den = [1 2 3];
rlocus(num, den)
```



$$G(s) = \frac{(s+2)(s+3)}{s(s+1)}$$




```
num = [1 5 6]
den = [1 1 0]
rlocus(num, den)
```

$$\cancel{Q(s) = 1 + K\frac{B(s)}{A(s)} = 0}$$

$$\cancel{K = -\frac{A(s)}{B(s)}}$$

$$\begin{cases} Q(s) = (s+2)^2 = 0 & s_b = -2, -2 \\ \frac{dQ(s)}{ds} = 2(s+2) = 0 & s_b = -2. \end{cases}$$

or

$$Q(s) = 1 + K\frac{N(s)}{D(s)} = 0$$

$$-K = +\frac{D(s)}{N(s)}$$ has multiple roots at s_b

$$\cancel{Q(s) = 1\,K + \frac{D(s)}{N(s)} = 0}$$

$$\frac{dQ(s)}{ds} = K \cdot \frac{N'(s)D(s) - D'(s)N(s)}{+D(s)^2} = 0$$

$$-\frac{dK}{ds} = \frac{D'(s)N(s) - D(s)N'(s)}{N(s)^2} = 0$$

⇒ Rule

$$\boxed{\begin{array}{l} N'(s)D(s) - D'(s)N(s) = 0 \\ \text{to find } s_b \text{ (break in, -away points)} \end{array}}$$

ex) 1. $1(s^2+2s+3)\ (s+2)(2s+2) = 0$

$$-(s^2+2s+3) + (2s^2+2s+4s+4) = 0$$

$$s^2+4s+1 = 0$$

$$s_b = -2 \pm \sqrt{4-1}$$
$$= -2 \pm \sqrt{3}$$