1. (35 points) An open-loop transfer function is given by,
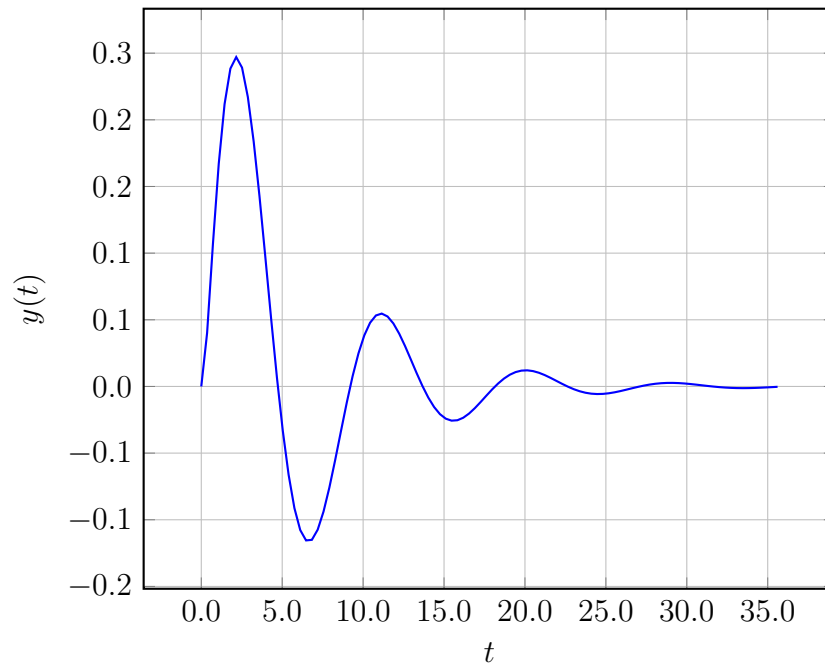
$$G(s) = \frac{1}{s^3 + 2.0s^2 + 3.22221s + 7.22221}$$

Which of the following PI controllers stabilizes the system in a unit-feedback closed-loop configuration?
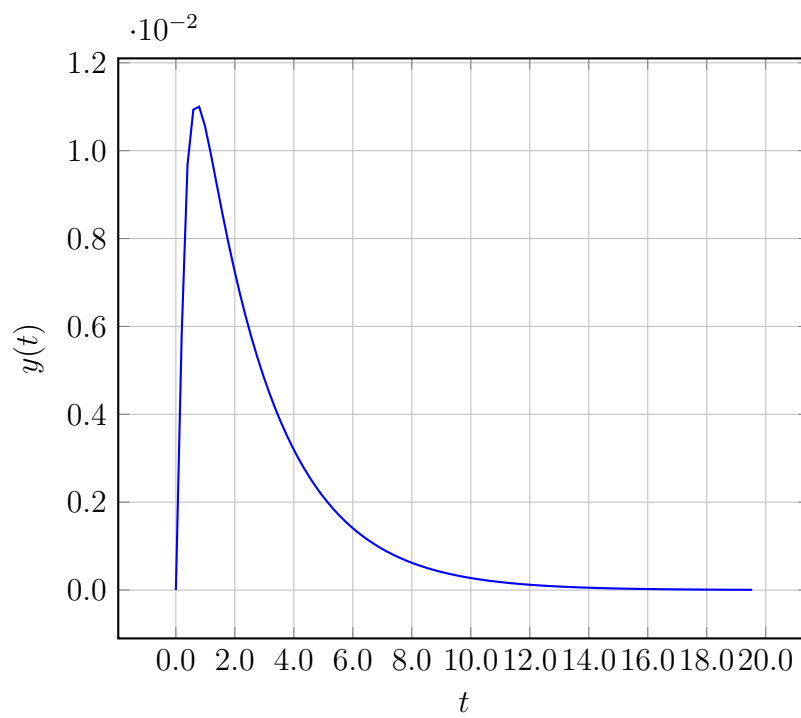
A. $F(s) = -2.94444 + \frac{0.72221}{s}$

B. $F(s) = 1.83333 + \frac{1.44444}{s}$

C. $F(s) = -8.66667 + \frac{2.94444}{s}$

D. $F(s) = 1.38889 + \frac{2.94444}{s}$

E. $F(s) = -9.11111 + \frac{1.44444}{s}$

2. (35 points) Which one of the following unit impulse responses corresponds to a system that does not overshoot when subjected to a unit step input?
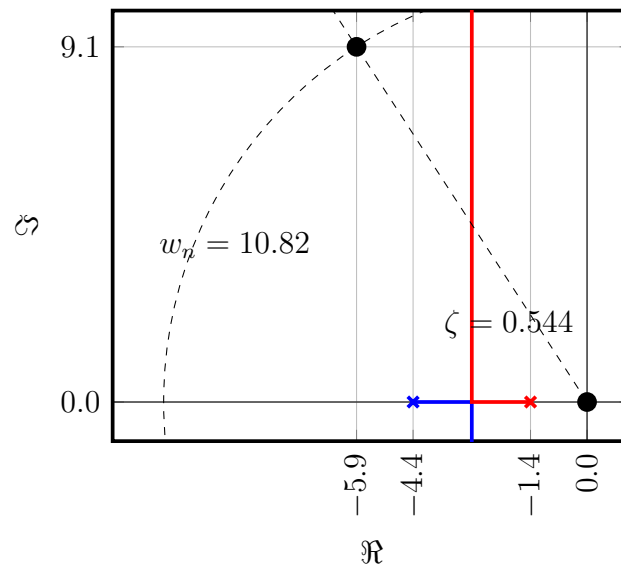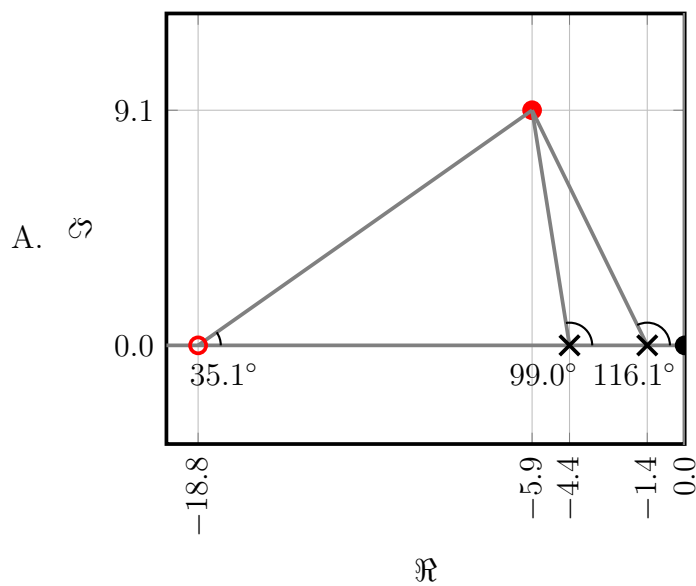
A.

B.

3. (30 points) A design point on the root-locus plot for a P-type controller is shown below.
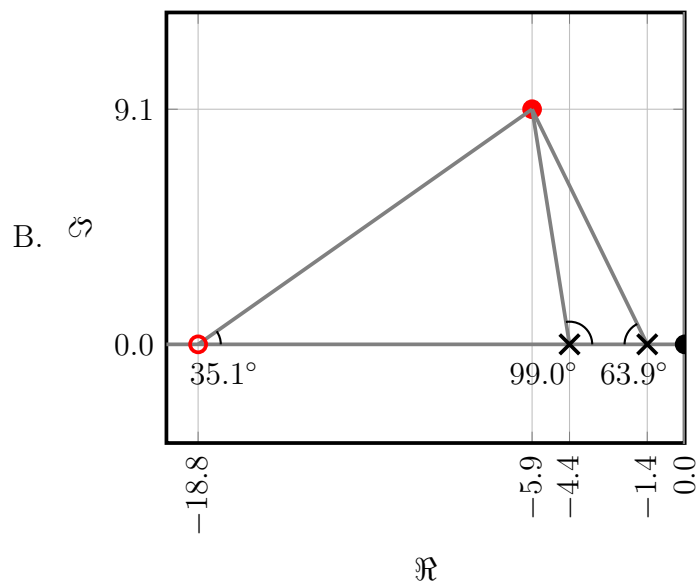

$w_n = 10.82$

$\zeta = 0.544$

A zero is added so that the root-locus passes through this design point. Which of the following represents the correct angle condition for this design?
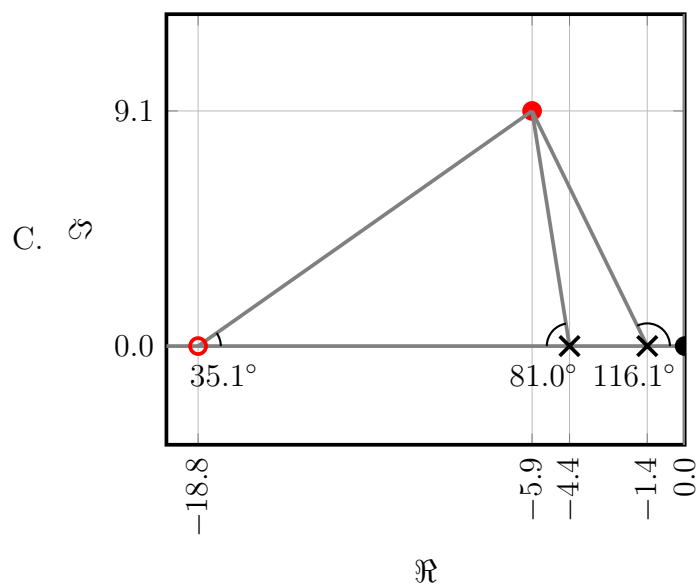
$$\sum \theta = 116.1° + 99.0° + 35.1° =$$

A.

35.1°   99.0°   116.1°

$$\sum\theta = 63.9° + 99.0° + 35.1° =$$

B. $\Im$

9.1

0.0

35.1°   99.0° 63.9°

-18.8 -5.9 -4.4 -1.4 0.0

$\Re$

$$\sum\theta = 116.1° + 81.0° + 35.1° =$$

C. $\Im$

9.1

0.0

35.1°   81.0° 116.1°

-18.8 -5.9 -4.4 -1.4 0.0

$\Re$

$$\sum \theta = 116.1° + 99.0° + 144.9° =$$

D.

$$\sum \theta = 116.1° + 99.0° - 35.1° =$$

E.