

1. (35 points) An open-loop transfer function is given by,

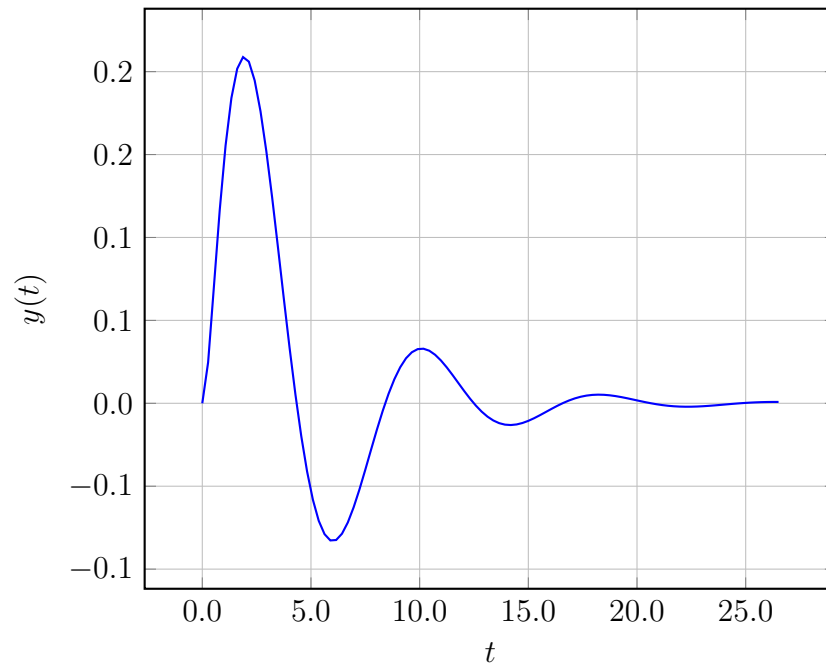
$$G(s) = \frac{1}{s^3 + 2.0s^2 + 3.30302s + 7.30302}$$

Which of the following PI controllers stabilizes the system in a unit-feedback closed-loop configuration?

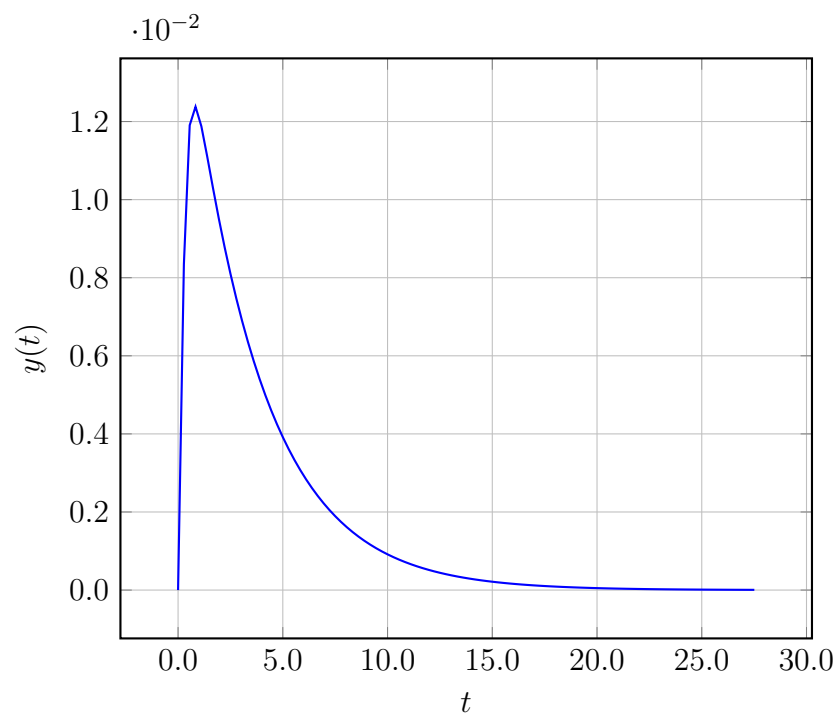
- A.  $F(s) = 2.31818 + \frac{1.60605}{s}$
- B.  $F(s) = -3.10605 + \frac{0.80302}{s}$
- C.  $F(s) = -8.18182 + \frac{3.10605}{s}$
- D.  $F(s) = -8.78789 + \frac{1.60605}{s}$
- E.  $F(s) = 1.71211 + \frac{3.10605}{s}$

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?

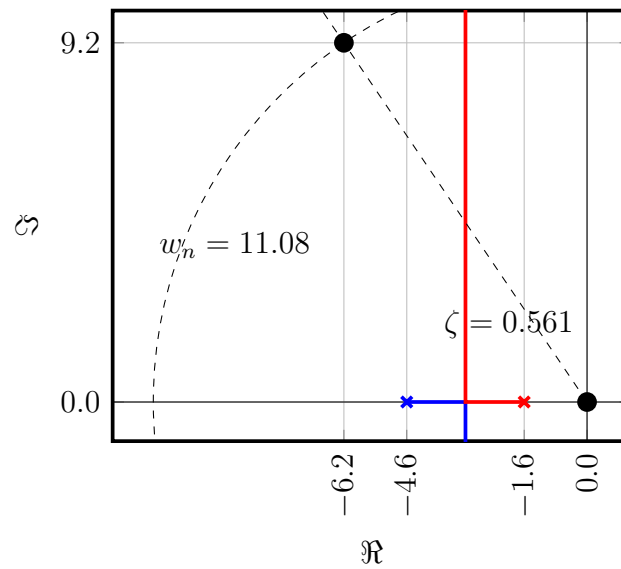
A.



B.

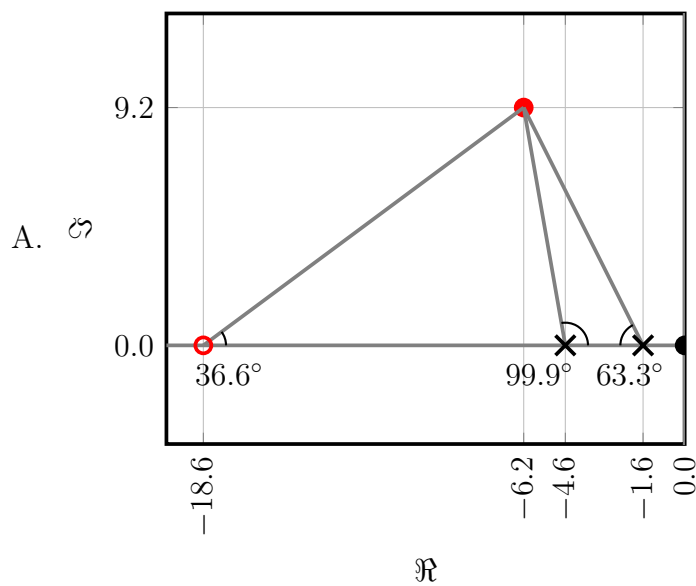


3. (30 points) A design point on the root-locus plot for a P-type controller is shown below.

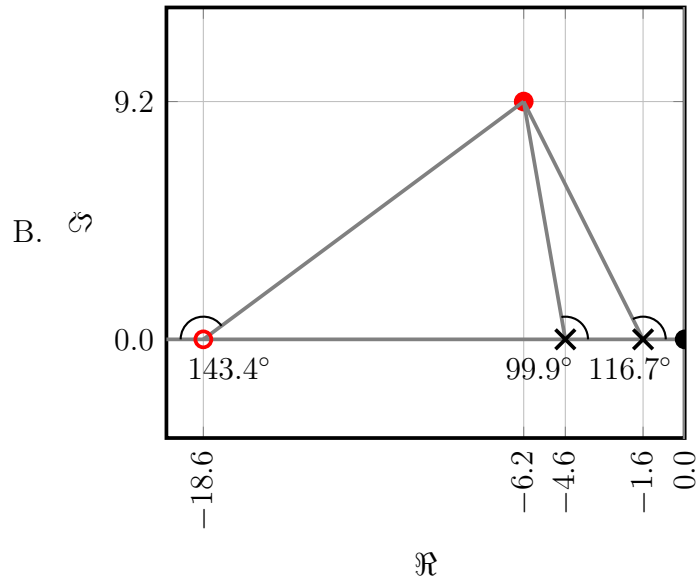


A zero is added so that the root-locus passes through this design point. Which of the following represents the correct angle condition for this design?

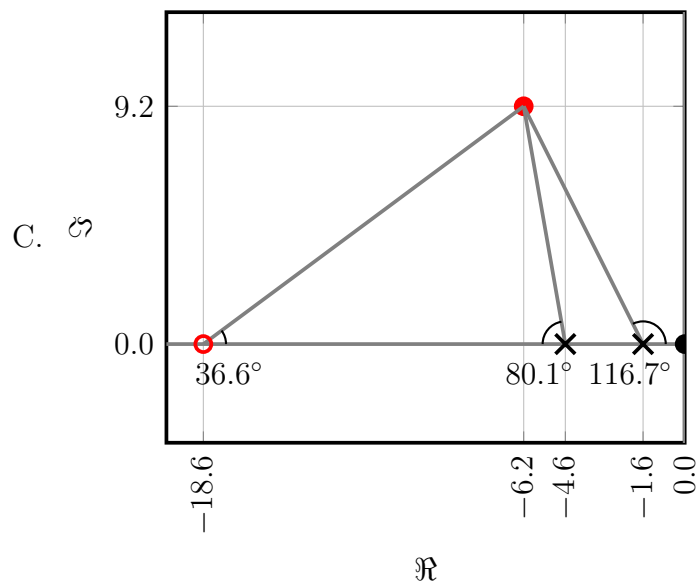
$$\sum \theta = 63.3^\circ + 99.9^\circ + 36.6^\circ =$$



$$\sum \theta = 116.7^\circ + 99.9^\circ + 143.4^\circ =$$



$$\sum \theta = 116.7^\circ + 80.1^\circ + 36.6^\circ =$$



$$\sum \theta = 116.7^\circ + 99.9^\circ - 36.6^\circ =$$

