

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

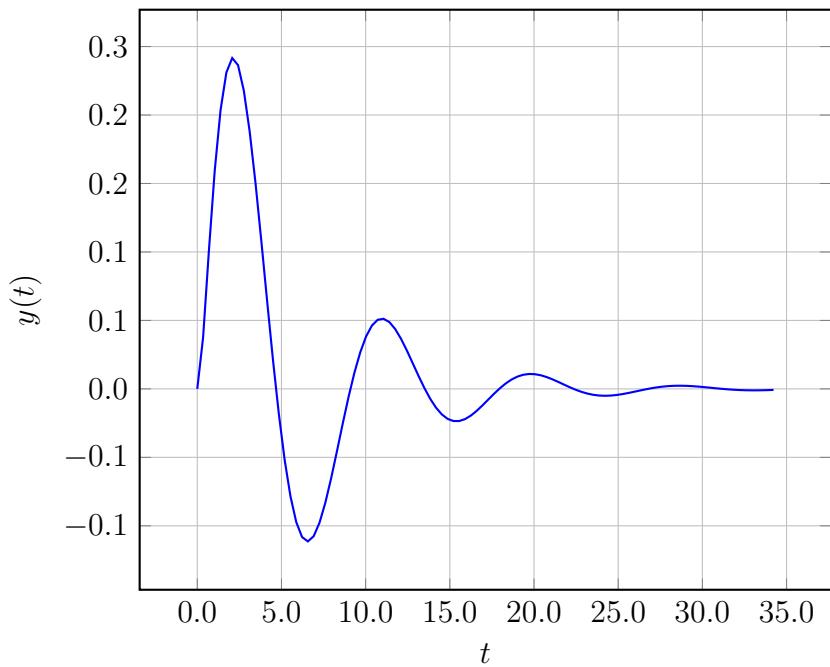
$$G(s) = \frac{1}{s^3 + 2.0s^2 + 3.23232s + 7.23232}$$

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

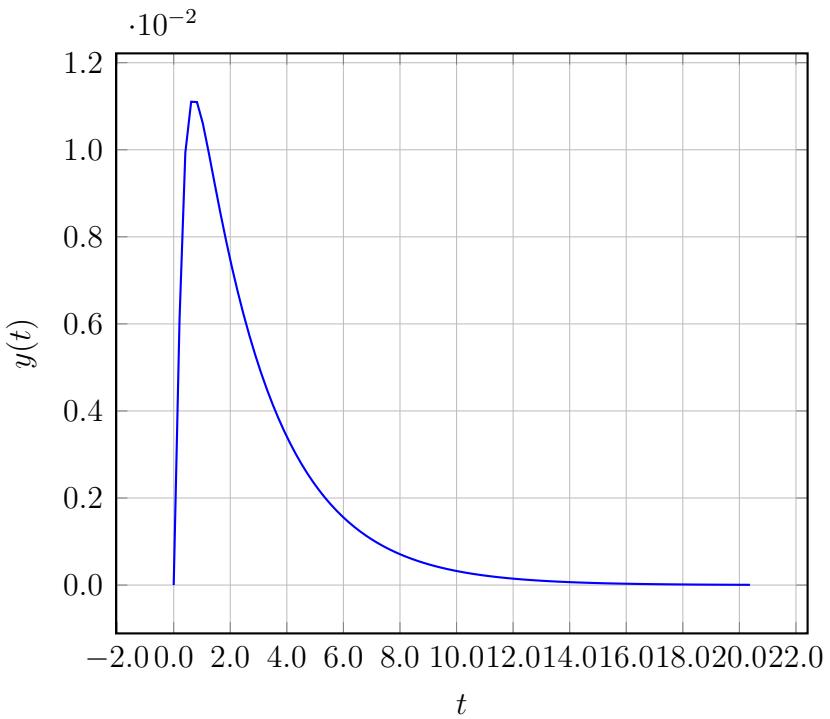
- A. $F(s) = -9.07071 + \frac{1.46465}{s}$
- B. $F(s) = -8.60606 + \frac{2.96465}{s}$
- C. $F(s) = 1.89394 + \frac{1.46465}{s}$
- D. $F(s) = 1.42929 + \frac{2.96465}{s}$
- E. $F(s) = -2.96465 + \frac{0.73232}{s}$

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?

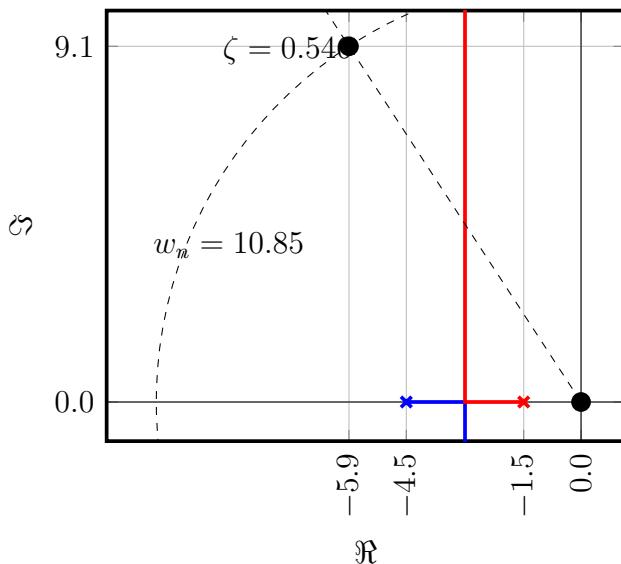
A.



B.

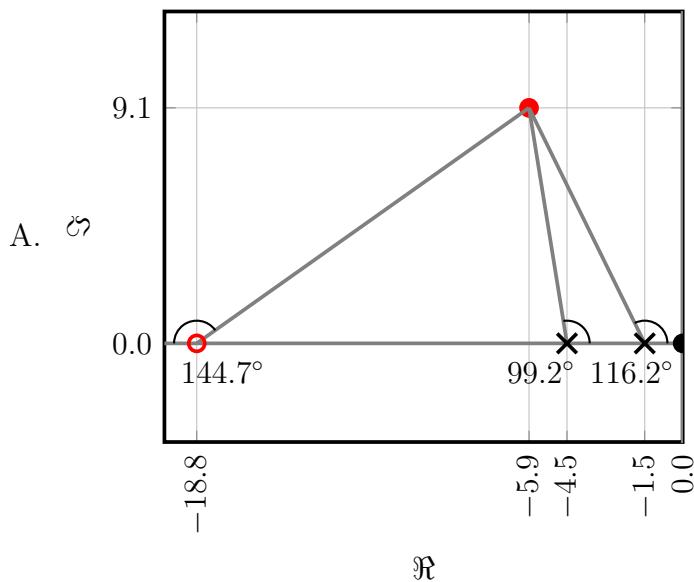


3. (30 points) A design point on the root-locus plot for a P-type controller is shown below.

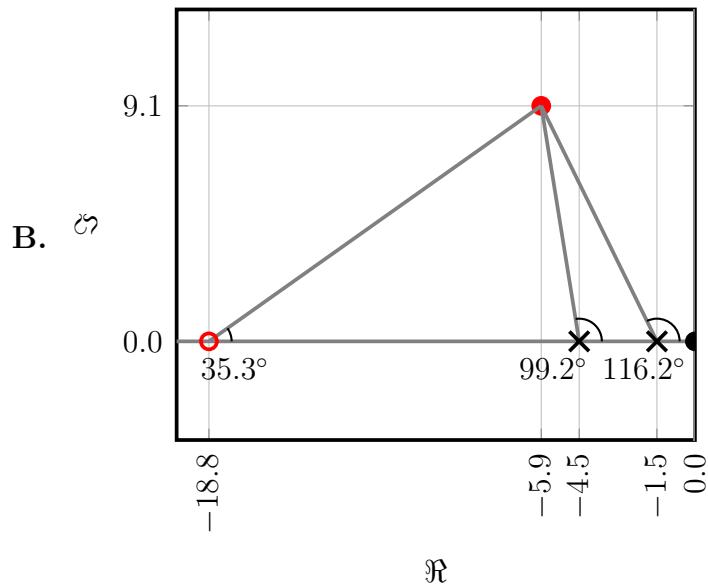


A zero is added so that the root-locus passes through this design point. Which of the following represents the correct angle condition for this design?

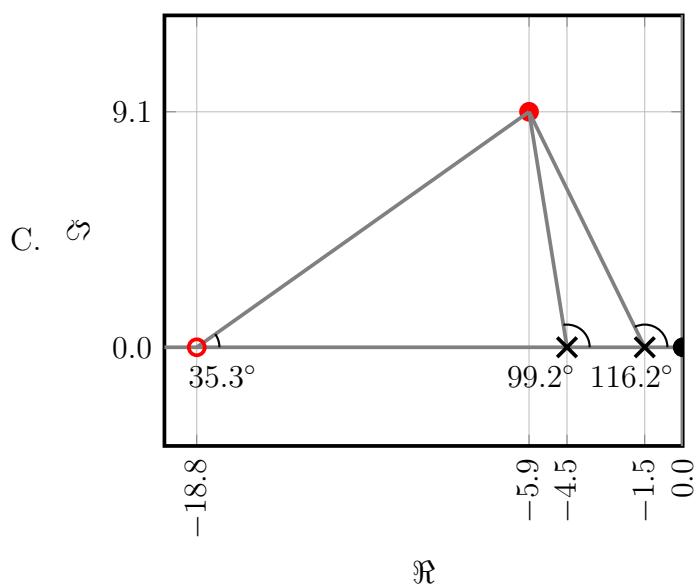
$$\sum \theta = 116.2^\circ + 99.2^\circ + 144.7^\circ = 360.0^\circ$$



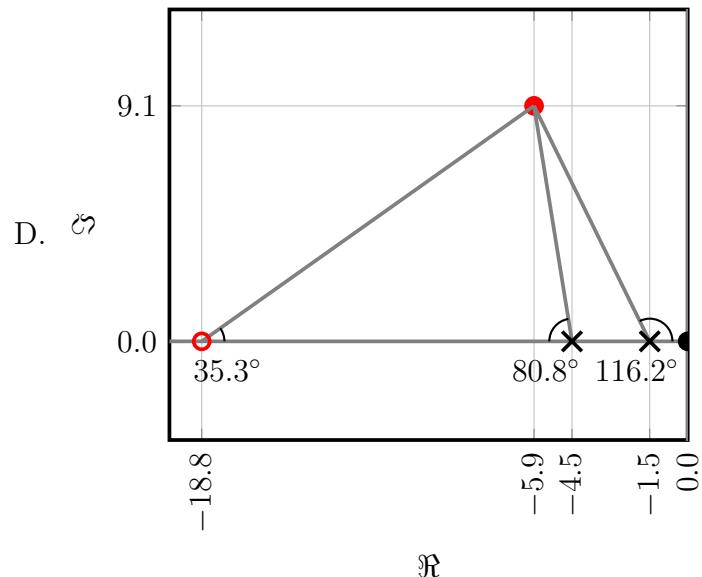
$$\sum \theta = 116.2^\circ + 99.2^\circ - 35.3^\circ = 180.0^\circ$$



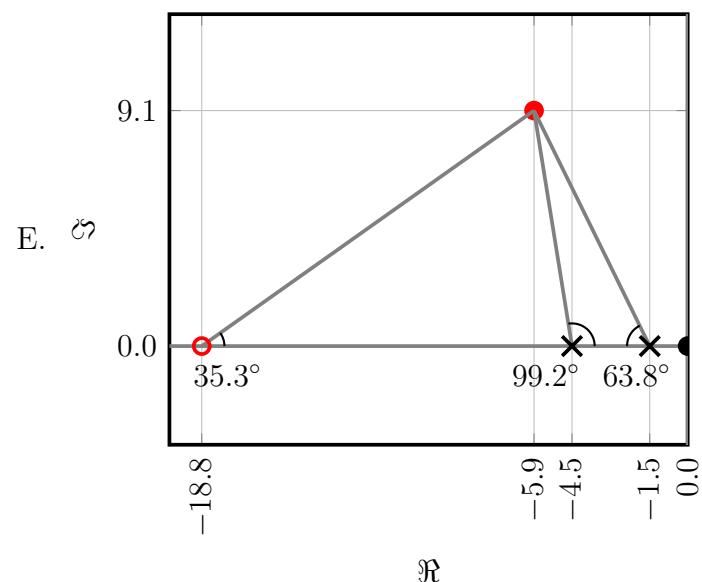
$$\sum \theta = 116.2^\circ + 99.2^\circ + 35.3^\circ = 250.6^\circ$$



$$\sum \theta = 116.2^\circ + 80.8^\circ + 35.3^\circ = 232.3^\circ$$



$$\sum \theta = 63.8^\circ + 99.2^\circ + 35.3^\circ = 198.3^\circ$$



| Q | A |
|---|---|
| 1 | E |
| 2 | B |
| 3 | B |