

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

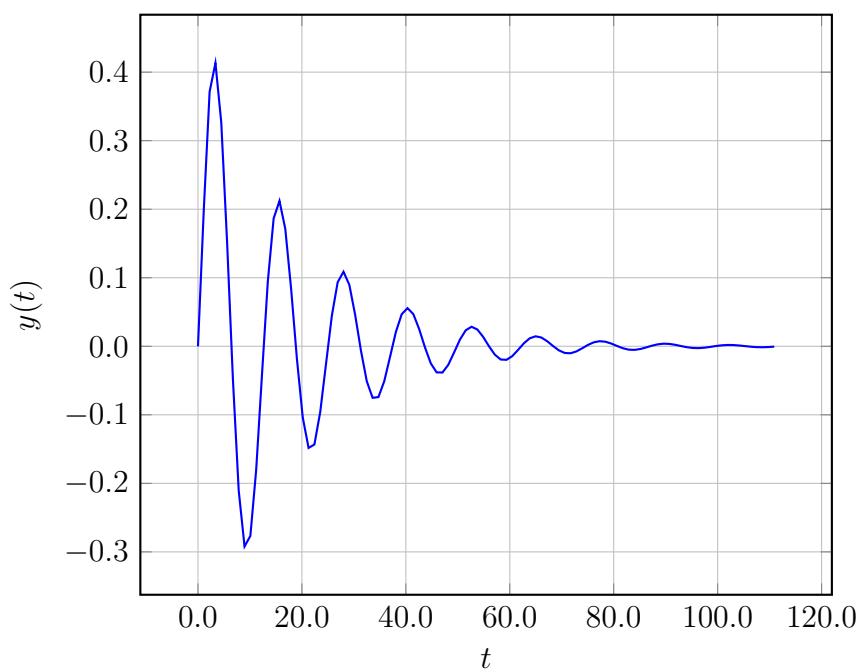
$$G(s) = \frac{1}{s^3 + 2.0s^2 + 3.01009s + 7.01009}$$

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

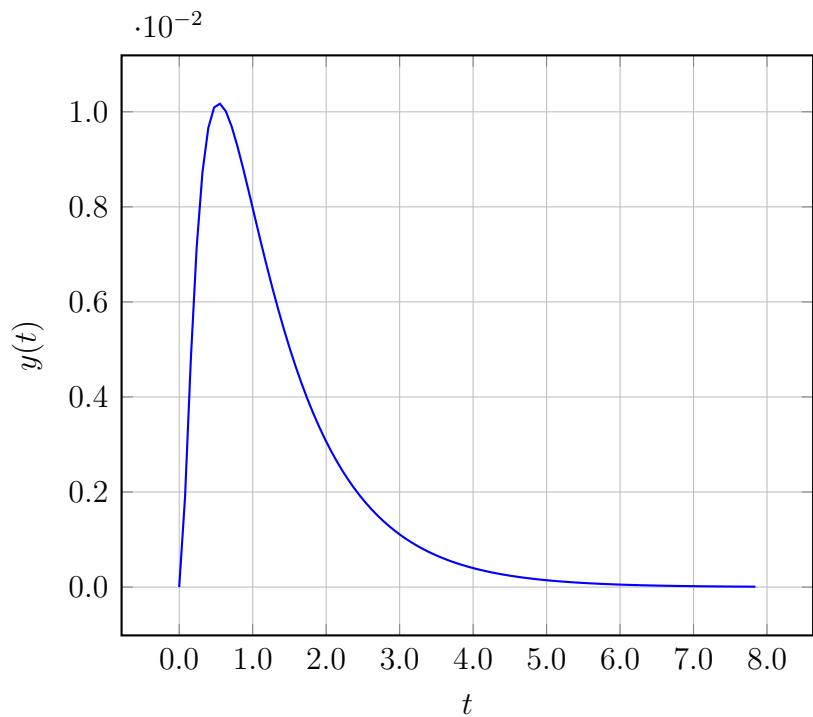
- A.  $F(s) = -9.9394 + \frac{2.52019}{s}$
- B.  $F(s) = 0.54039 + \frac{2.52019}{s}$
- C.  $F(s) = 0.5606 + \frac{1.02019}{s}$
- D.  $F(s) = -9.95961 + \frac{1.02019}{s}$
- E.  $F(s) = -2.52019 + \frac{0.51009}{s}$

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?

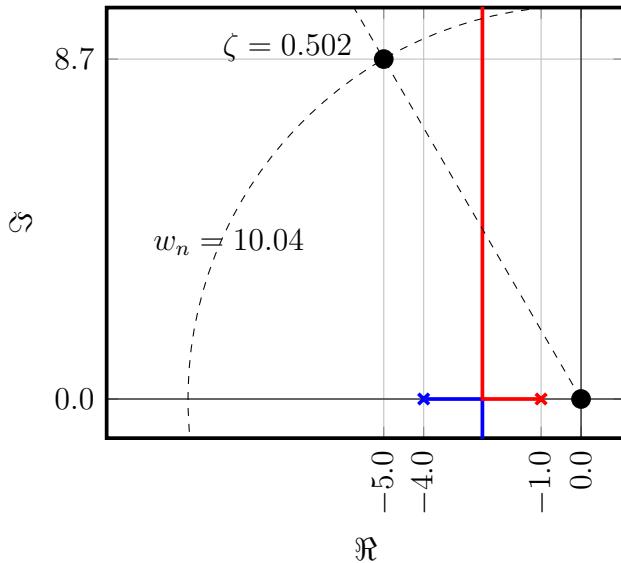
A.



B.

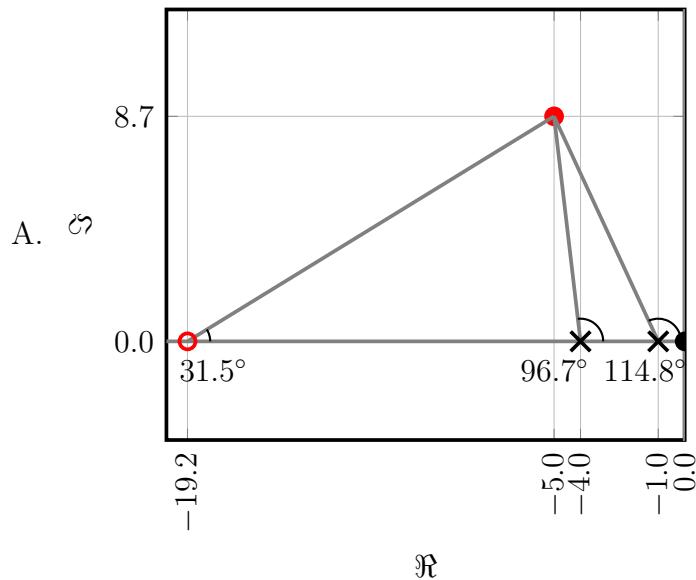


3. (30 points) A design point on the root-locus plot for a P-type controller is shown below.

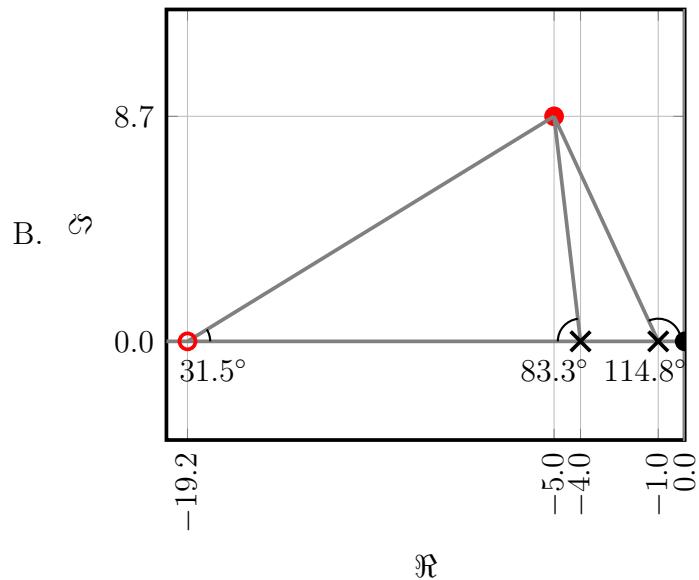


A zero is added so that the root-locus passes through this design point. Which of the following represents the correct angle condition for this design?

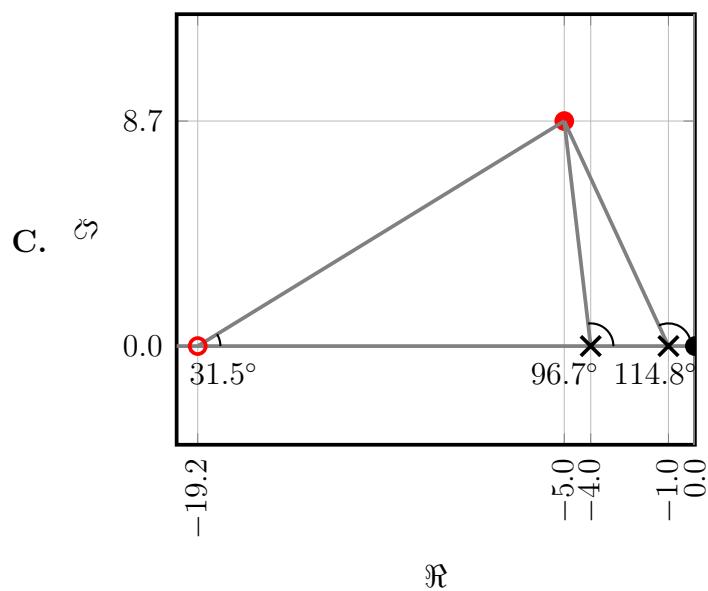
$$\sum \theta = 114.8^\circ + 96.7^\circ + 31.5^\circ = 243.1^\circ$$



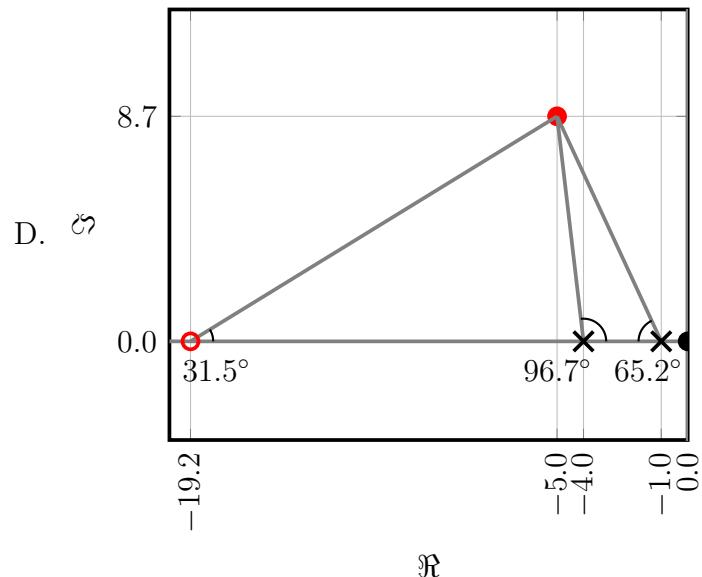
$$\sum \theta = 114.8^\circ + 83.3^\circ + 31.5^\circ = 229.7^\circ$$



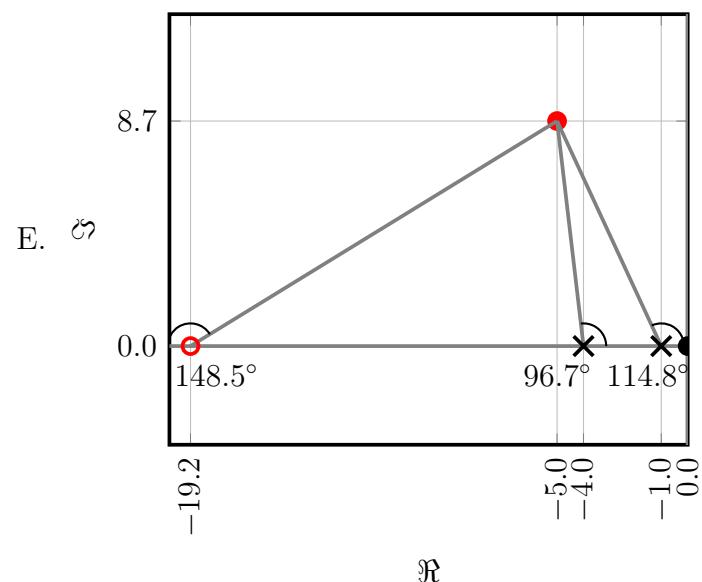
$$\sum \theta = 114.8^\circ + 96.7^\circ - 31.5^\circ = 180.0^\circ$$



$$\sum \theta = 65.2^\circ + 96.7^\circ + 31.5^\circ = 193.4^\circ$$



$$\sum \theta = 114.8^\circ + 96.7^\circ + 148.5^\circ = 360.0^\circ$$



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