

Needham, Chapter 7, Exercise 1

G. Palmer, February 20, 2017, 1:15 pm PST

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Interior: $N(p)$ odd

Exterior: $N(p)$ even

This is supported by the discussion on p. 340-41, end of §I. If a point p near a **closed loop** K oriented from left to right travels **along a ray** towards the loop without crossing it, then it is exterior. If it crosses the loop once and no part of K lies beyond, p is an interior point and the winding number $v(K, p)$ increases by one. As more lines are crossed, each one increases or decreases the winding number by one according to the left to right (+) or right to left (-) orientation of the loop with respect to p . If the ray then crosses twice on a back loop, i.e. a "cancelling pair", the influence on the winding number is zero. Needham says "In general, the number of intersection points will be $|n|$, or $|n| + 2$, or $|n| + 4$, etc." Point p is interior if and only if the number of times K is crossed is odd.