This problem asks whether or not it is possible to determine the composition of an iron-carbon alloy for which the mass fraction of eutectoid cementite is 0.109; and if so, to calculate the composition. Yes, it is possible to determine the alloy composition; and, in fact, there are two possible answers. For the first, the eutectoid cementite exists in addition to proeutectoid cementite. For this case the mass fraction of eutectoid cementite \( W_{Fe_3C''} \) is just the difference between total cementite and proeutectoid cementite mass fractions; that is

\[
W_{Fe_3C''} = W_{Fe_3C} - W_{Fe_3C'}
\]

Now, it is possible to write expressions for \( W_{Fe_3C} \) (of the form of Equation 9.12) and \( W_{Fe_3C'} \) (Equation 9.23) in terms of \( C_0 \), the alloy composition. Thus,

\[
W_{Fe_3C''} = \frac{C_0 - C_\alpha}{C_{Fe_3C} - C_\alpha} - \frac{C_0 - 0.76}{5.94}
\]

\[
= \frac{C_0 - 0.022}{6.70 - 0.022} - \frac{C_0 - 0.76}{5.94} = 0.109
\]

And, solving for \( C_0 \) yields \( C_0 = 0.84 \text{ wt}\% \ C \).

For the second possibility, we have a hypoeutectoid alloy wherein all of the cementite is eutectoid cementite. Thus, it is necessary to set up a lever rule expression wherein the mass fraction of total cementite is 0.109. Therefore,

\[
W_{Fe_3C} = \frac{C_0 - C_\alpha}{C_{Fe_3C} - C_\alpha} = \frac{C_0 - 0.022}{6.70 - 0.022} = 0.109
\]

And, solving for \( C_0 \) yields \( C_0 = 0.75 \text{ wt}\% \ C \).