Concept Question 12-8: When evaluating the expansion coefficients of a function containing repeated poles, is it more practical to start by evaluating the coefficient of the fraction with the lowest-order pole or that with the highest-order pole? Why?

It's easier to start with the highest order pole because it then can be used to compute the coefficients for the lower-order poles by applying differentiation.

Repeated Real Poles

Expansion coefficients B_1 to B_m are determined through a procedure that involves multiplication by $(\mathbf{s}+p)^m$, differentiation with respect to $\mathbf{s}$, and evaluation at $\mathbf{s}=-p$:

$$B_j = \left\{ \frac{1}{(m-j)!} \frac{d^{m-j}}{d\mathbf{s}^{m-j}} [(\mathbf{s}+p)^m \, \mathbf{F}(\mathbf{s})] \right\}\Bigg|_{\mathbf{s}=-p}, \quad j = 1, 2, \ldots, m. \qquad (12.62)$$

For the m, $m-1$, and $m-2$ terms, Eq. (12.62) reduces to:

$$B_m = (\mathbf{s}+p)^m \, \mathbf{F}(\mathbf{s})\big|_{\mathbf{s}=-p}, \qquad (12.63a)$$

$$B_{m-1} = \left\{ \frac{d}{d\mathbf{s}} [(\mathbf{s}+p)^m \, \mathbf{F}(\mathbf{s})] \right\}\Bigg|_{\mathbf{s}=-p}, \qquad (12.63b)$$

$$B_{m-2} = \left\{ \frac{1}{2!} \frac{d^2}{d\mathbf{s}^2} [(\mathbf{s}+p)^m \, \mathbf{F}(\mathbf{s})] \right\}\Bigg|_{\mathbf{s}=-p}. \qquad (12.63c)$$