APPENDIX E
DERIVATION OF JUMP CRITERIA BY RMS METHOD

E.1 Derivation of jump criteria

From equation (8.5)

\[ V_L^4 = \frac{1}{10K^5} \left( -6 \left( (1-C) + \frac{L}{R^2+L^2} \right) \right)^2 \left( 16 \left( (1-C) + \frac{L}{R^2+L^2} \right) - 20 \left( \frac{R}{R^2+L^2} + \frac{1}{r} \right) \right) \]

It is evident from equation (E.1) above that for the existence of two real positive roots of \( V_L \), the following conditions must be satisfied:

(i) \[ \left( 1 - C \right) + \frac{L}{R^2+L^2} < 0 \] \hspace{1cm} \text{.. (E.2)}

and

(ii) \[ 16 \left( (1-C) + \frac{L}{R^2+L^2} \right)^2 - 20 \left( \frac{R}{R^2+L^2} + \frac{1}{r} \right) \geq 0 \]

From relation (E.3) above,

\[ 16 \left( (1-C) + \frac{L}{R^2+L^2} \right)^2 \geq 20 \left( \frac{R}{R^2+L^2} + \frac{1}{r} \right) \]

or

\[ \left( 1 - C \right) + \frac{L}{R^2+L^2} \geq \frac{\sqrt{5}}{2} \left( \frac{R}{R^2+L^2} + \frac{1}{r} \right) \]

considering the negative sign, since

\[ c \geq 1 + \frac{L}{R^2+L^2} + \frac{\sqrt{5}}{2} \left[ \frac{R}{R^2+L^2} + \frac{1}{r} \right] \] \hspace{1cm} \text{.. (E.4)}
E.2 Jump criteria for $n^{th}$ order nonlinearity

From equation (8.11), we have

\[ V_L^{(n-1)} = \frac{(n+1)}{2nK_n} \left\{ (1-C) + \frac{L}{R^2+L^2} \right\} + \frac{1}{2} \left[ \frac{(n-1)}{2nK_n} \right]^2 \left\{ (1-C) + \frac{L}{R^2+L^2} \right\}^2 \]

or

\[ V_L^{(n-1)} = \frac{(n+1)}{2nK_n} \left\{ (1-C) + \frac{L}{R^2+L^2} \right\} + \frac{1}{2} \left[ \frac{(n-1)}{2nK_n} \right]^2 \left\{ (1-C) + \frac{L}{R^2+L^2} \right\} \]

\[ \left\{ \frac{R}{R^2+L^2} + \frac{1}{r} \right\}^2 \]

\[ \ldots \ldots \quad (E.5) \]

From equation (E.6), we have the following conditions, for the existence of two real positive roots:

(i) \[(1-C) + \frac{L}{R^2+L^2} < 0 \quad \ldots \ldots \quad (E.7)\]

(ii) \[\left\{ (1-C) + \frac{L}{R^2+L^2} \right\}^2 - 4 \left\{ \frac{R}{R^2+L^2} + \frac{1}{r} \right\}^2 \geq 0 \]

\[ \ldots \ldots \quad (E.8) \]

From condition (ii) above, we have

\[ \frac{\left\{ (1-C) + \frac{L}{R^2+L^2} \right\}^2 + 2 \left\{ \frac{R}{R^2+L^2} + \frac{1}{r} \right\}}{\sqrt{n}} \]
choosing the negative sign on the right hand side,

\[ 1 - C + \frac{L}{R + L^2} > - \frac{2\sqrt{n}}{(n-1)} \left[ \frac{R}{R^2 + L^2} + \frac{1}{r} \right] \]

or

\[ C > 1 + \frac{L}{R + L^2} + \frac{2\sqrt{n}}{(n-1)} \left[ \frac{R}{R^2 + L^2} + \frac{1}{r} \right] \quad \text{(E.9)} \]

E.3 DERIVATION OF THE CONDITIONS FOR THE EXISTENCE
OF CRITICAL VALUES OF R AND L & JUMP-TO POINTS ETC.

The equations for the determination of critical values of R and L and jump-to points by phasor approach are found to be identical with that obtained by IDF approach. Therefore Appendix D may be referred for various mathematical relations pertaining to the critical linear parameters and computation of jump-to points.