

Total: 24 marks

Objective

1 Key knowledge and worked examples

Two rows from odd/even coefficients, each new row by cross-multiplication; sign changes in the first column = RHP roots. A zero first-column entry needs epsilon; a whole zero row needs the auxiliary equation.

$s^4 + 2s^3 + 3s^2 + 4s + 5$: rows give first column 1, 2, 1, -6, 5 – two sign changes, two RHP roots (exact roots: $-1.29 \pm j0.86$ and $+0.29 \pm j1.42$ ✓).

$s^5 + 2s^4 + 24s^3 + 48s^2 + 50s + 100$ produces a zero s^3 row: the auxiliary equation $2s^4 + 48s^2 + 100 = 0 \rightarrow j\omega$ roots $\pm j1.52, \pm j4.66$ and one LHP root at -2 – marginally stable (sustained oscillation), not asymptotically stable.

2 Practice

3 Exam-style questions

3.2 A unity-feedback loop has plant $K/[s(s+1)(s+2)]$.

Write the characteristic equation. Apply Routh to find the stability range of K. At the critical K, give the frequency of sustained oscillation (via the auxiliary equation). Confirm by computing the roots at $K = 4$ that the system is inside the stable range there. [7]

