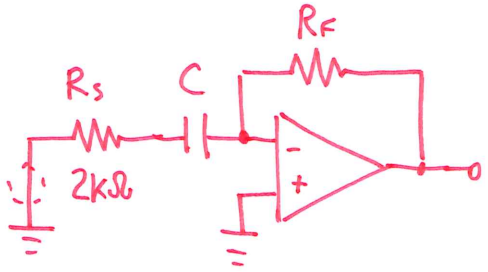
Practical Differentiator: Loop Gain

1

Set all independent sources equal to zero

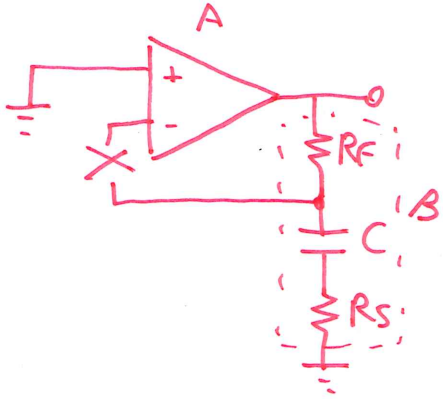


2

Break feedback loop (don't change loading)

2A

Redraw in A, β format for clarity (optional)



$$\beta(s) = \frac{R_S + \frac{1}{sC}}{R_S + \frac{1}{sC} + R_F} \cdot \frac{sC}{sC}$$

$$\beta(s) = \frac{1 + sR_SC}{1 + s(R_S + R_F)C}$$

ZERO: β POLE

3

Find
$|A|, |\beta|$ $\angle A, \angle\beta$

ZERO: $f_z = \frac{1}{2\pi R_S C} = \frac{1}{2\pi (2k)(0.01\mu F)} = 8\,kHz$ } NEW

POLE: $f_p = \frac{1}{2\pi (R_S + R_F)C} = \frac{1}{2\pi (102\,k\Omega)(0.01\mu F)} = 158\,Hz$ } ≈ SAME

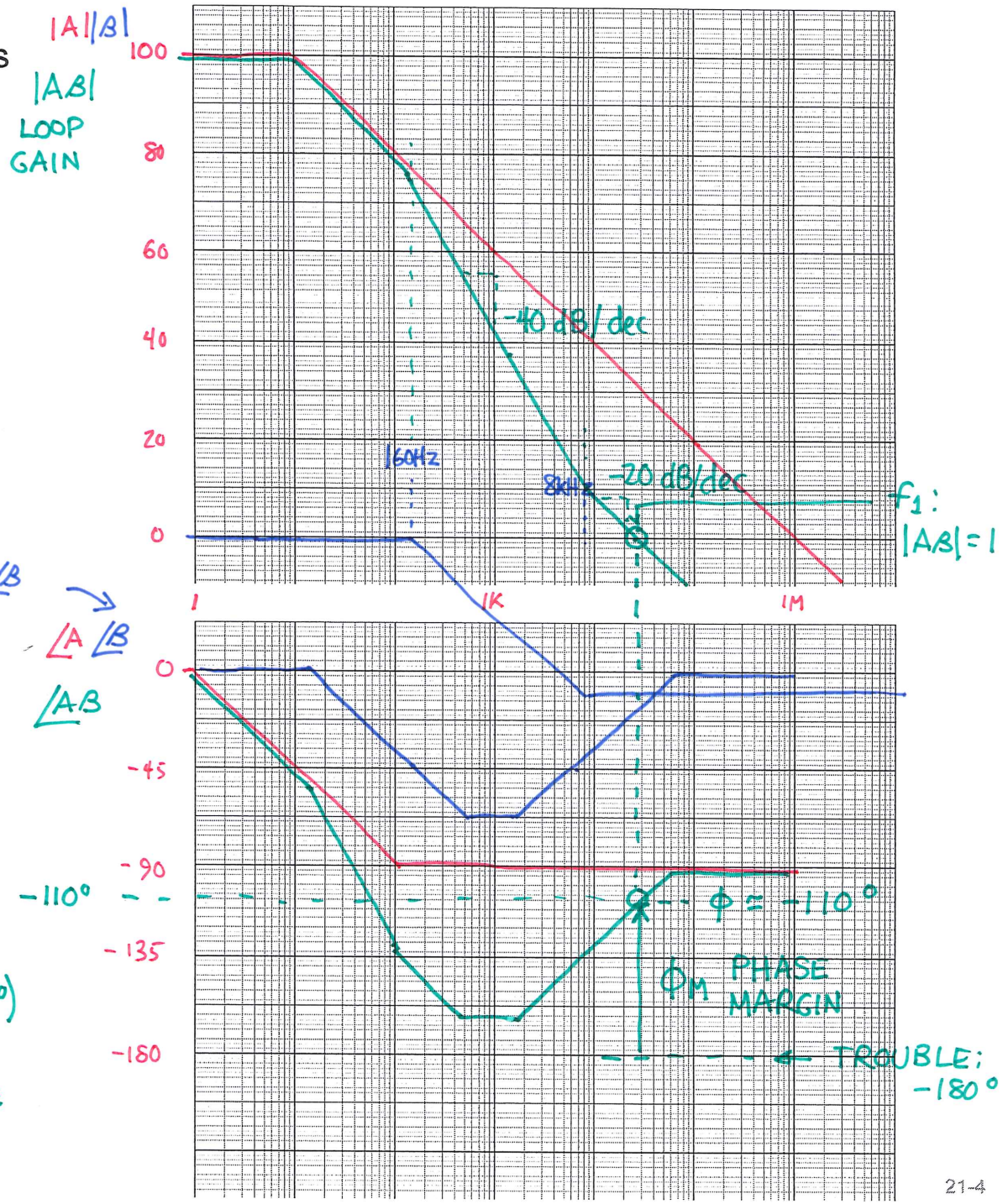
Practical Differentiator: Stability Analysis

1

Plot Loop Gain

$|A\beta|\angle A\beta$

|A| SAME



CONDITION FOR OSCILLATION:

POLES ON jω AXIS IN CLOSED LOOP $\frac{V_{out}}{V_{in}}$

$1 + A(f)\beta(f) = 0$

$A(f)\beta(f) = -1$

2

Find f_1

Frequency at which $|A\beta| = 1$

90° PHASE LEAD IN ∠B DUE TO ZERO IN B(s) AT 8 kHz

3

Check $\angle A\beta$ at f_1 compared to -180°

$\phi_M = \angle AB|_{f_1} - (-180°)$

$\phi_M = 70°$ STABLE