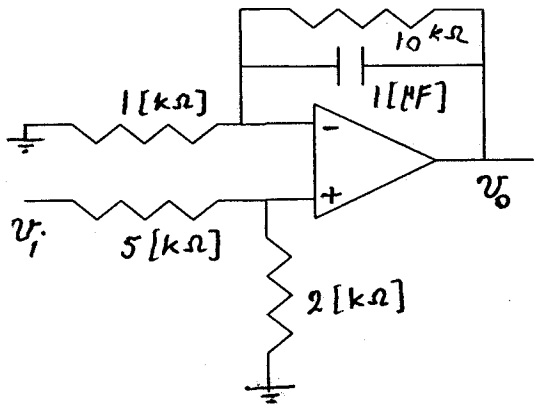
(ECE3455, Q3) In the circuit shown,

a) Find the transfer function.
b) Find the frequency at which the input and output amplitudes are equal.
c) Find the phase difference between input and output at this frequency.

Hint: You can use either Bode plot or analytic method for Part(b) and (c) or both or the sake of comparison.



Solution:

$$Z_2 = 10[k] \parallel 1[MF] = \left(10^4 \times \frac{1}{10^{-6}s}\right)\frac{1}{10^4 + \frac{1}{10^{-6}s}}$$

$$Z_2 = \frac{10^4}{1 + 10^{-2}s}$$

$$\frac{V_o}{V_i} = \left[1 + \frac{Z_2}{1k\Omega}\right]\left[\frac{2}{2+5}\right] = \left[1 + \frac{10}{1+10^{-2}s}\right]\left[\frac{2}{7}\right]$$

$$T(s) = \frac{V_o}{V_i} = \frac{11 + 10^{-2}s}{1 + 10^{-2}s} \times 0.285 = 3.13\,\frac{(1 + s/1100)}{1 + s/100}$$

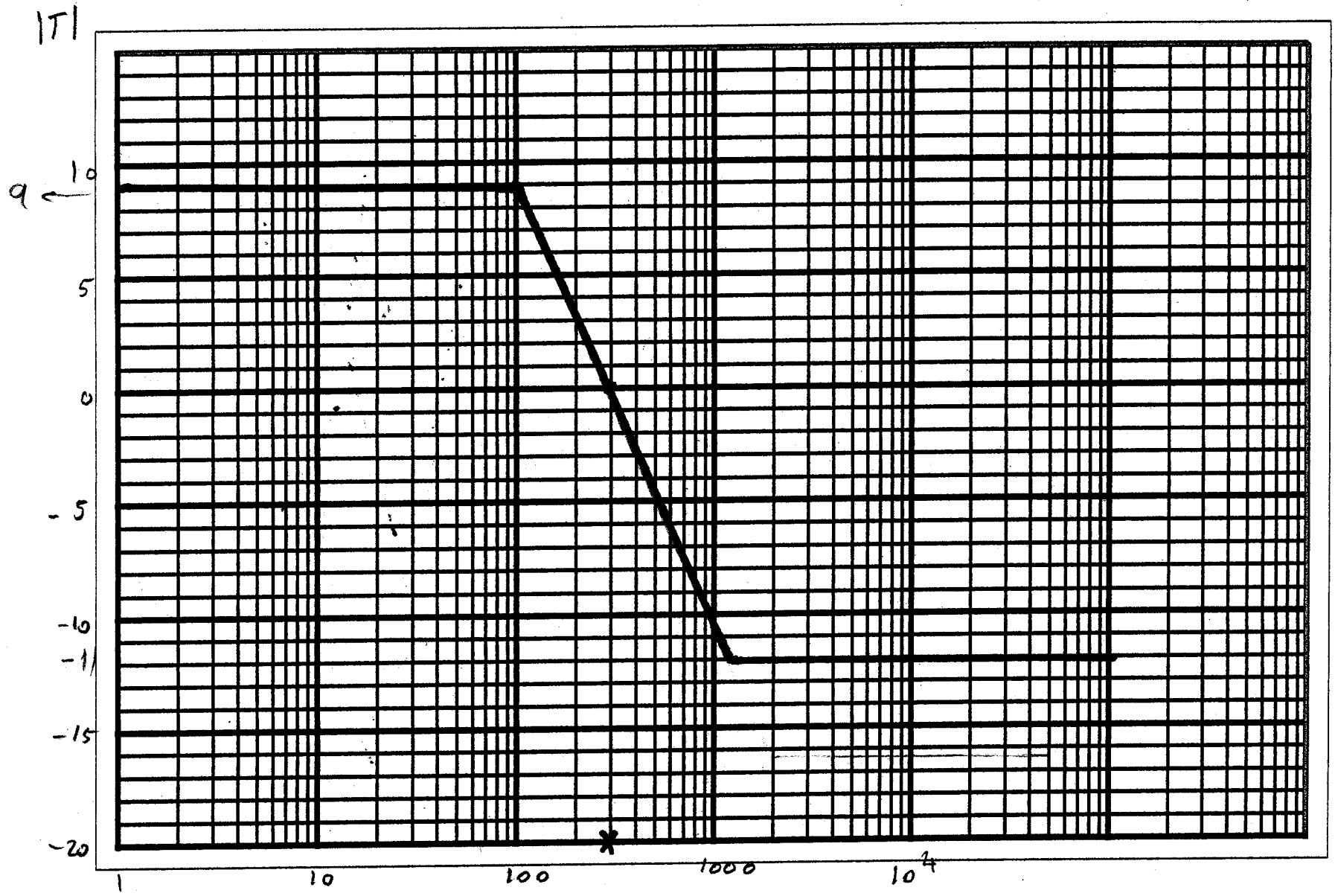
ω is around 300 rad/sec from bode Plot (magnitude) where the gain is (1)

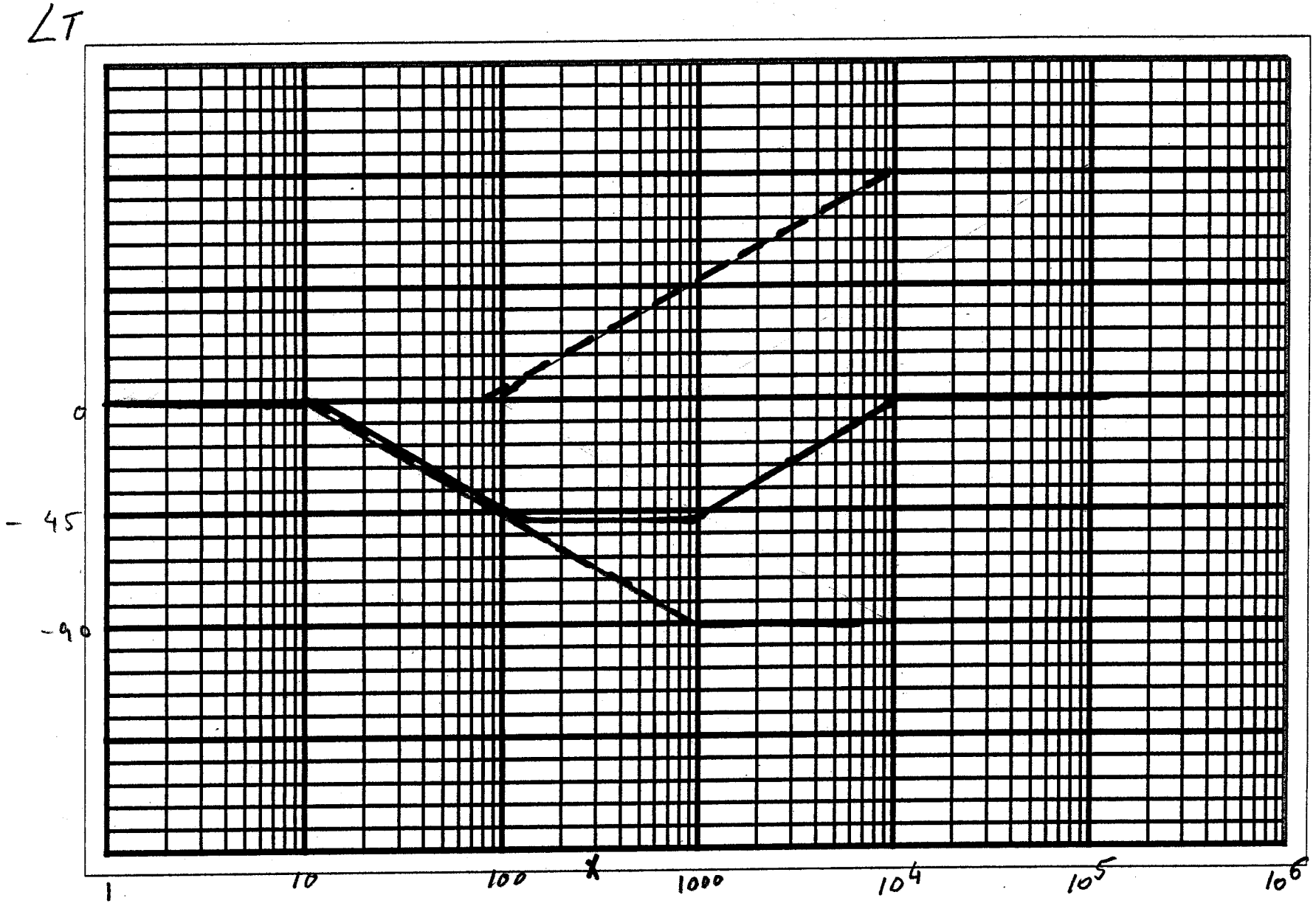
and the Phase difference is arounnd -50° at this freq.

Exact values are 313 rad/s and -57°

Since $|T| = 3.13\sqrt{\frac{1 + \omega^2/1100^2}{1 + \omega^2/100^2}} = 1 \Rightarrow \omega = 313$

$$\angle T = \tan^{-1}\frac{313}{1100} - \tan^{-1}\frac{313}{100} = -57^\circ$$


|T|
9
10
5
0
-5
-10
-11
-15
-20
1
10
100
1000
10^4


∠T
0
-45
-90
1
10
100
1000
10^4
10^5
10^6
f