Q1. $G(S)\,H(S) = \dfrac{80}{S(S+2)(S+20)}$

$= \dfrac{80}{2 \times 20 \times S\left(\frac{S}{2}+1\right)\left(\frac{S}{20}+1\right)}$

① $= \dfrac{2}{S(0.5S+1)(0.05S+1)}$

② $= \dfrac{2}{j\omega(0.5j\omega+1)(0.05j\omega+1)}$

③ $Y(j\omega) = \dfrac{K}{j\omega} = \dfrac{2}{j\omega}$

④ $|20\log(j\omega)| = 20\log 2 - 20\log(j\omega)$

$= 20\log 2 - 20\log(0.1)$

$= 6.02 - (-20)$

$= 26\ dB$

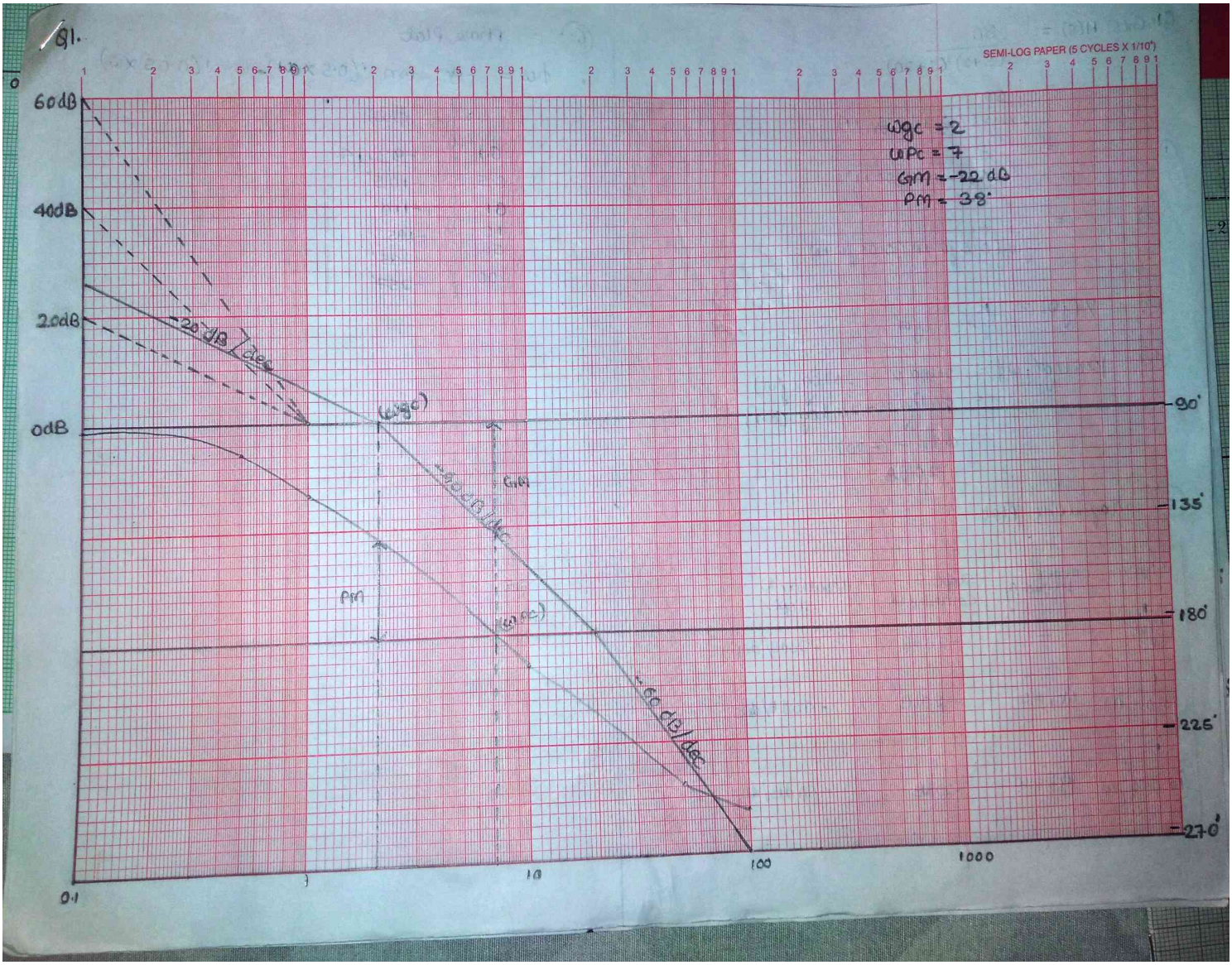
⑤ Magnitude Plot

Term	corner frequency	Slope contributed	Resultant slope
$\frac{1}{j\omega}$	—	-20dB	-20dB/dec
$\frac{1}{(j\omega 0.5+1)}$	$\omega_{c_1}=2$	-20dB	-40dB/dec
$\frac{1}{(1+0.05j\omega)}$	$\omega_{c_2}=20$	-20dB	-60dB/dec

⑥ Phase Plot

$\phi\omega = -90° - \tan^{-1}(0.5 \times \omega) - \tan^{-1}(0.05 \times \omega)$

ω	$\phi(\omega)$
0.1	-93.14°
0.5	-105°
1	-119°
10	-195°
50	-245°
100	-257°


Q1.
SEMI-LOG PAPER (5 CYCLES X 1/10")
60dB
40dB
20dB
0dB
-20 dB/dec
-40 dB/dec
-60 dB/dec
ωgc
ωpc
GM
PM
ωgc = 2
ωPc = 7
GM = -22 dB
PM = 38°
90°
135°
180°
225°
270°
0.1
1
10
100
1000

Q2. $G(s)H(s) = \frac{100(0.1s+1)}{s(s+1)^2(0.01s+1)}$

① $= \frac{100(1+0.1s)}{s(1+s)^2(1+0.01s)}$ Transfer fun is already in standard form.

② $= \frac{100(1+0.1j\omega)}{j\omega(j\omega+1)^2(1+0.01j\omega)}$

③ $Y(j\omega) = \frac{100}{j\omega}$

④ $|20\log G(j\omega)| = 20\log 100 - 20\log 0.1$
$= 60\ dB$

⑤ Magnitude Plot

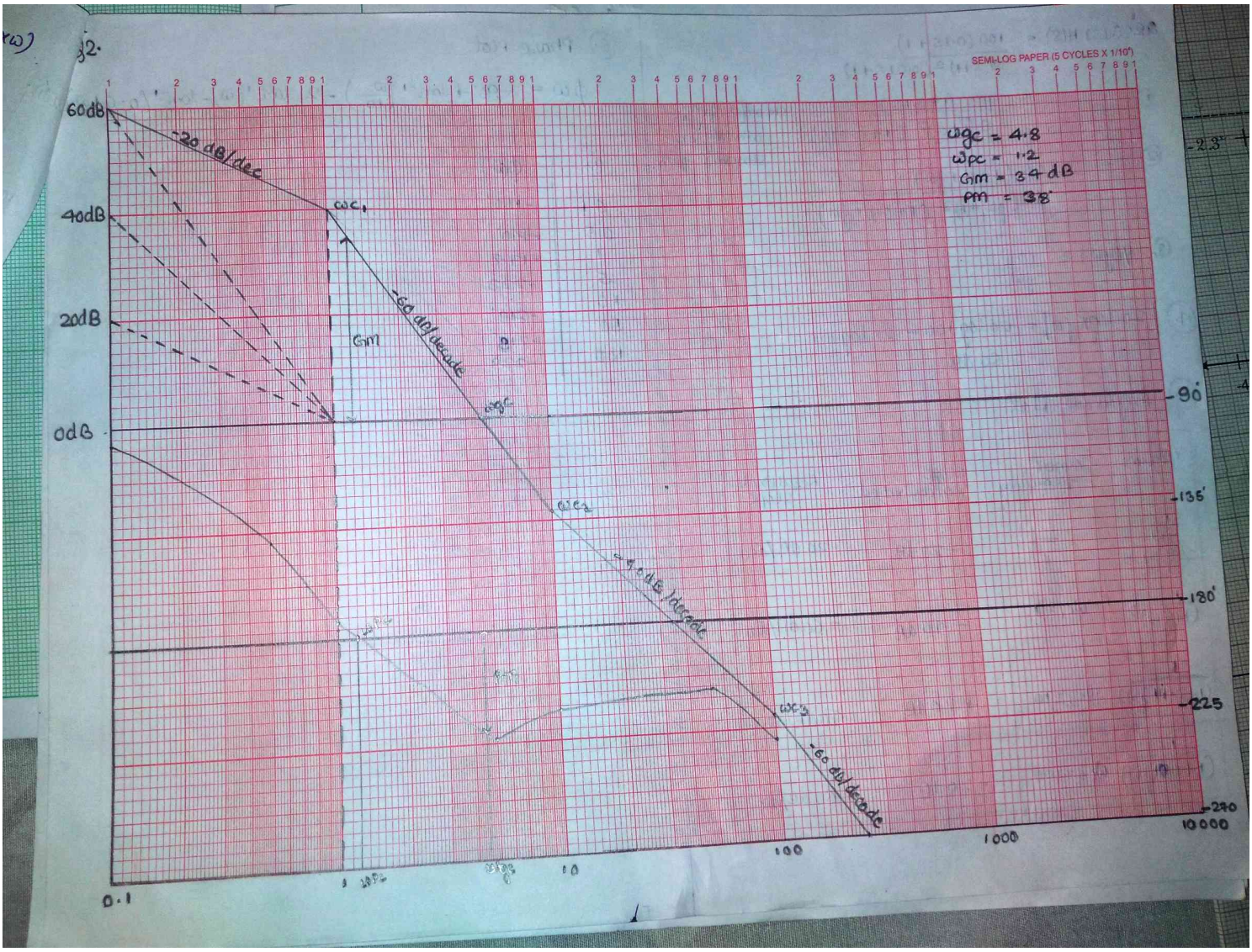
Term	corner frequency	slope contributed	Resultant slope
$\frac{1}{j\omega}$	—	−20 dB	−20 dB/dec
$\frac{1}{(1+j\omega)^2}$	$\omega_{c_1} = 1$	−40 dB	−60 dB/dec
$(1+0.1j\omega)$	$\omega_{c_2} = 10$	+20 dB	−40 dB/dec
$\frac{1}{(1+0.01j\omega)}$	$\omega_{c_3} = 100$	−20 dB	−60 dB/dec

$\omega_{c_2} = 20$ rad/sec

⑥ Phase Plot

$\phi\omega = -90° + \tan^{-1}\left(\frac{\omega}{10}\right) - 2\tan^{-1}(\omega) - \tan^{-1}(0.01\omega$

ω	$\phi(\omega)$
0.1	−100°
0.5	−140°
1	−174
5	−223
10	−219°
50	−215°
100	−229


SEMI-LOG PAPER (5 CYCLES X 1/10")
60dB
40dB
20dB
0dB
-20 dB/dec
ωc1
GM
-60 dB/decade
ωc2
-40 dB/decade
ωc3
-60 dB/decade
ωgc = 4.8
ωpc = 1.2
GM = 34 dB
PM = 38°
-90°
-135°
-180°
-225°
-270°
0.1
1
10
100
1000
10000

Q3. $G(s)H(s) = \frac{300(s+2)}{s^2(s+10)(s+40)}$

$= \frac{4(0.5s+1)}{s^2(0.1s+1)(0.025s+1)}$

① $= \frac{4(0.5j\omega+1)}{j\omega^2(0.1j\omega+1)(0.025j\omega+1)}$

② $Y(j\omega) = \frac{4}{(j\omega)^2}$

③ $|Y(j\omega)| = |[20\log(4) - 20\log(0.1)^2]|$

$= |[20\log(4) - 40\log(0.1)]|$

$= 52$ dB

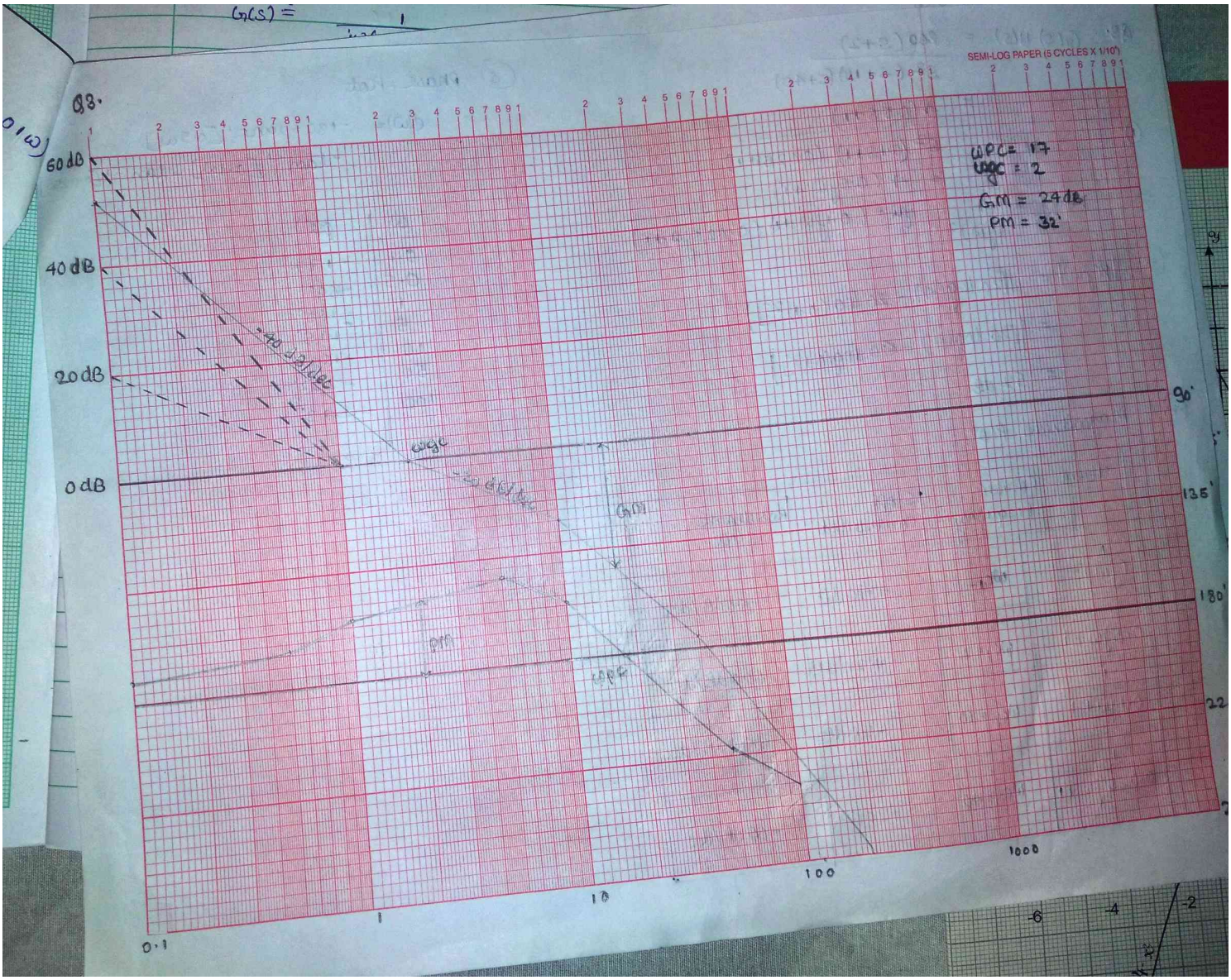
④ Magnitude Plot

Term	Corner Frequency	Slope contributed	Resultant slope
$\frac{1}{(j\omega)^2}$	—	-40dB	-40dB/dec
$0.5j\omega+1$	$\omega c_1 = 2$	+20dB	-20dB/dec
$\frac{1}{0.1j\omega+1}$	$\omega c_2 = 10$	-20dB	-40dB/dec
$\frac{1}{0.025j\omega+1}$	$\omega c_3 = 40$	-20dB	-60dB/dec

⑤ Phase - Plot

$\phi(\omega) = -180 + \tan^{-1}[0.5\omega] - \tan^{-1}[0.1\omega] - \tan^{-1}[0.0$

ω	$\phi(\omega)$
0.1	-177°
0.5	-169°
1	-160°
5	-145°
10	-160°
50	-222°
100	-243°


SEMI-LOG PAPER (5 CYCLES X 1/10")
60dB
40dB
20dB
0dB
-40 dB/dec
-20 dB/dec
wgc
wpc
GM
PM
WPC= 17
WGC = 2
GM = 24 dB
PM = 32°
90°
135°
180°
0.1
1
10
100
1000

Q4. $G(S)H(S) = \frac{250}{S(S+2)(S+10)}$

$= \frac{12.5}{S(S/2+1)(S/10+1)}$

$= \frac{12.5}{j\omega(0.5j\omega+1)(0.1j\omega+1)}$

$Y(j\omega) = \frac{k}{j\omega} = \frac{12.5}{j\omega}$

$|Y(j\omega)| = |20\log(12.5) - 20\log(0.1)|$

$= 41.9 \simeq 42\,dB$

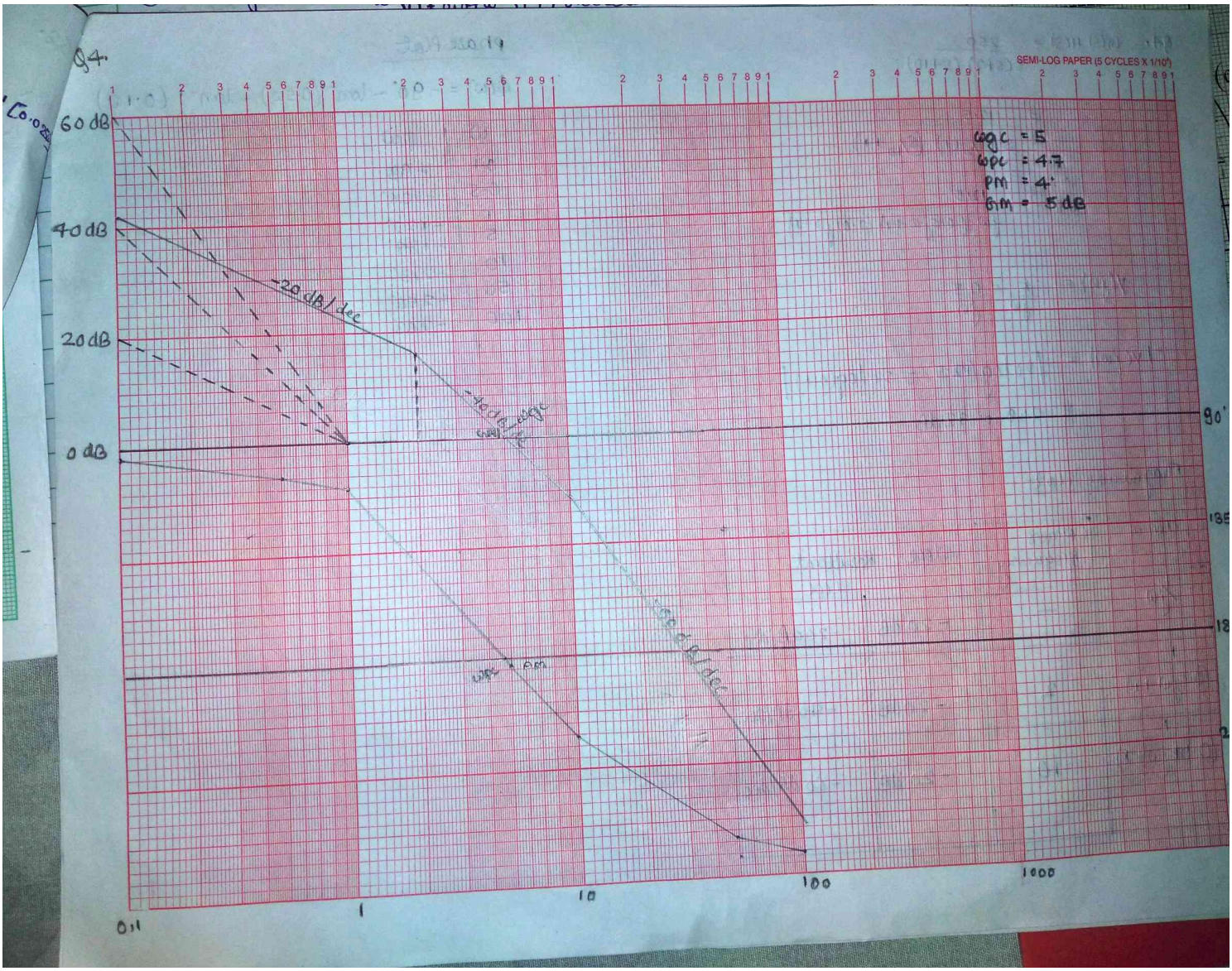
Magnitude Plot

Term	Corner frequency	Slope	Resultant slope
$1/j\omega$	—	-20 dB	-20 dB/dec
$\frac{1}{(0.5j\omega+1)}$	2	-20 dB	-40 dB/dec
$\frac{1}{(0.1j\omega+1)}$	10	-20 dB	-60 dB/dec

Phase Plot

$\phi(\omega) = -90° - \tan^{-1}(0.5\omega) - \tan^{-1}(0.1\omega$

ω	$\phi\omega$
0.1	-93
0.5	-106°
1	-122°
5	-184°
10	-213°
50	-256°
100	-263°


Q4.
SEMI-LOG PAPER (5 CYCLES X 1/10⁰)
60 dB
40 dB
20 dB
0 dB
-20 dB/dec
-40 dB/dec
-60 dB/dec
ωgc = 5
ωpc = 4.7
ϕM = 4°
GM = 5 dB
90°
0.1
1
10
100
1000

Q5. $G(s)H(s) = \dfrac{K(1+0.2s)(1+0.025s)}{s^3(1+0.001s)(1+0.005s)}$

$= \dfrac{K(1+0.2j\omega)(1+0.025j\omega)}{j\omega^3(1+0.001j\omega)(1+0.005j\omega)}$

③ $Y(j\omega) = \dfrac{K}{j\omega^3}$

④ $|20\log(j\omega)| = |20\log(1) - 20\log(j\omega)^3|$

$= |20\log(1) - 60\log(0.1)|$

$= 60$ dB

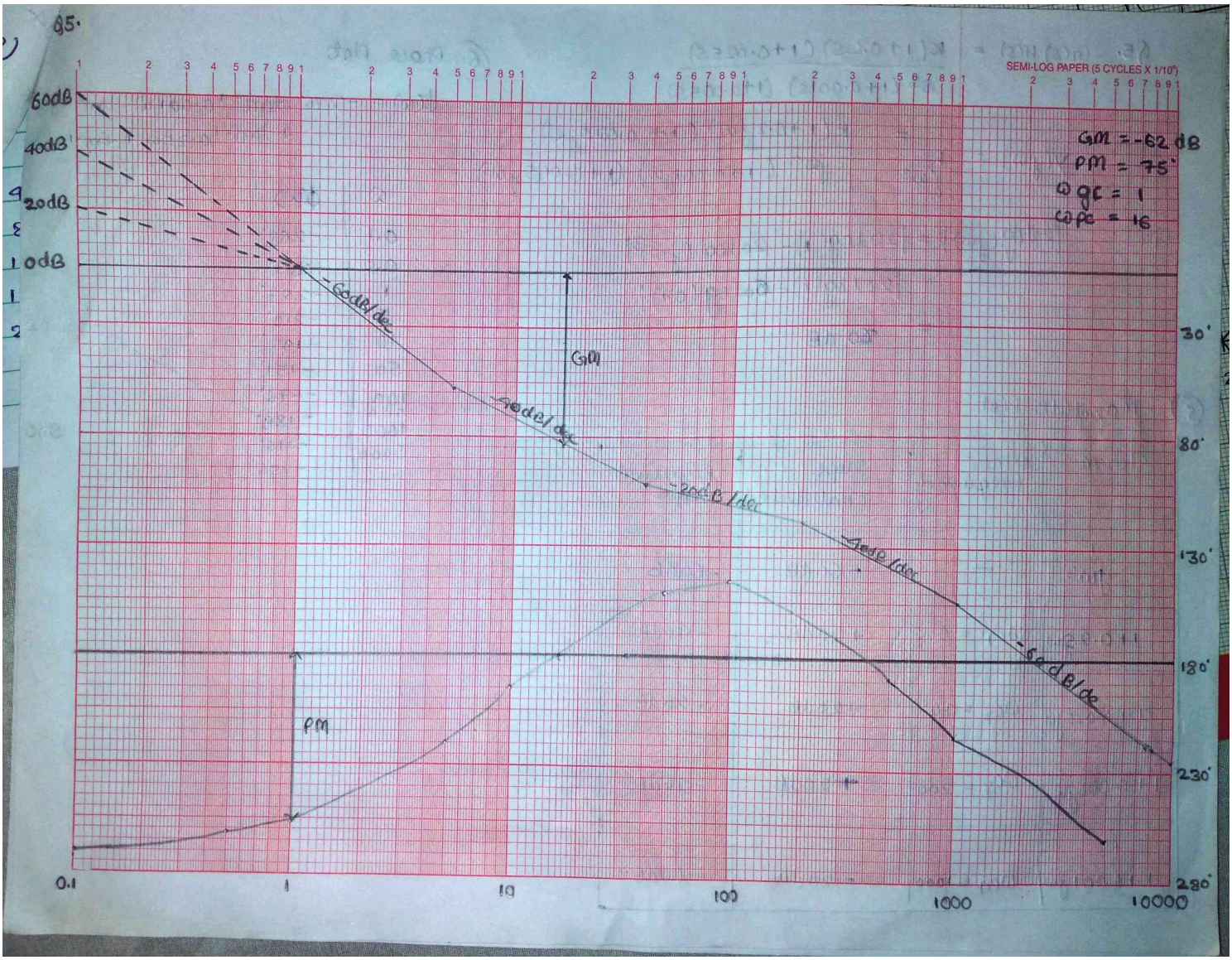
⑤ Magnitude Plot

Term	Corner Frequency	Slope contributed	Resultant Slope
$\frac{1}{j\omega^3}$	—	−60 dB	−60 dB
$1+0.2j\omega$	$\omega_{c1} = 5$	+20 dB	−40 dB
$1+0.025j\omega$	$\omega_{c2} = 40$	+20 dB	−20 dB
$\frac{1}{1+0.005j\omega}$	$\omega_{c3} = 200$	−20 dB	−40 dB
$\frac{1}{1+0.001j\omega}$	$\omega_{c4} = 1000$	−20 dB	−60 dB

⑥ Phase Plot

$\phi(\omega) = -270° - \tan^{-1}0.001\omega - \tan^{-1}0.005\omega + \tan^{-1}0.25\omega + \tan^{-1}0.2\omega$

ω	$\phi(\omega)$
0.1	−268°
0.5	−268°
1	−257°
5	−219°
10	−195°
50	−151°
100	−146°
500	−189°
1000	−216°
5000	−256°


85.
SEMI-LOG PAPER (5 CYCLES X 1/10")
60dB
40dB
20dB
10dB
GM = -62 dB
PM = 75°
ω gc = 1
ω pc = 16
-60dB/dec
-40dB/dec
-20dB/dec
-40dB/dec
-60dB/dec
GM
PM
30°
80°
130°
180°
230°
280°
0.1
1
10
100
1000
10000

Q6. $G(S)\,H(S) = \dfrac{200(s+2)}{s(s^2+10s+100)}$

① $= \dfrac{400(0.5s+1)}{100s(0.01s^2+0.1s+1)}$

$= \dfrac{4(0.5s+1)}{s(0.01s^2+0.1s+1)}$

② $s = j\omega$

$\dfrac{4(0.5j\omega+1)}{j\omega(0.01j\omega^2+0.1j\omega+1)}$

③ $Y(j\omega) = 4/j\omega$

④ $|Y(j\omega)| = |20\log(4) - 20\log(0.1)|$

$= 32\,dB$

⑤ Magnitude plot

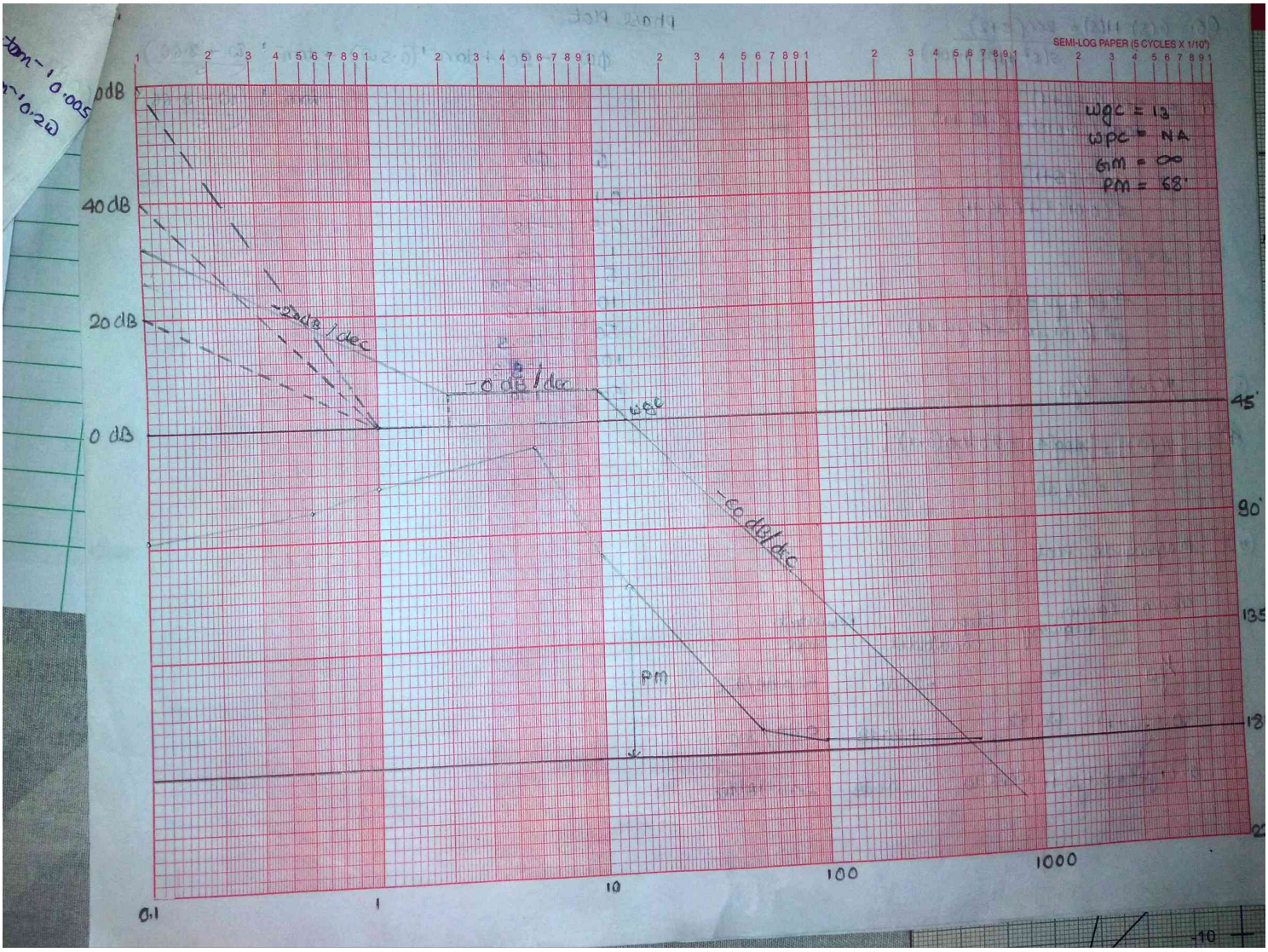
Term	Corner frequency	Slope contributed	Resultant slope
$1/j\omega$	—	-20 dB	-20 dB/dec
$(0.5j\omega+1)$	$\omega_{c_1}=2$	$+20$ dB	0 dB/dec
$\dfrac{1}{0.01j\omega^2+0.1j\omega+1}$	$\omega_{c_1}=10$	-40 dB	-40 dB/dec

Phase Plot

$\phi\omega = -90° + \tan^{-1}(0.5\omega) - \tan^{-1}\left(\dfrac{\omega+8.66}{5}\right)$

$- \tan^{-1}\left(\dfrac{\omega-8.66}{5}\right)$

ω	$\phi\omega$
0.1	−87
0.5	−78
1	−69
5	−55.49
10	−101.3
50	−170.5
100	−175.3
500	−179


SEMI-LOG PAPER (5 CYCLES X 1/10")
ωgc = 13
ωpc = NA
GM = ∞
PM = 68°
40 dB
20 dB
0 dB
-20dB/dec
-0 dB/dec
ωgc
-60 dB/dec
PM
45°
90°
135°
0.1
1
10
100
1000

$\omega_{C_2} = 20$ rad/sec

Q7. $G(s)H(s) = \dfrac{300(s^2+2s+4)}{s(s+10)(s+20)}$

$= \dfrac{4 \times 300\,(0.25s^2+0.5s+1)}{10 \times 20\, s\,(0.1s+1)(0.05s+1)}$

$= \dfrac{6\,(0.25j\omega^2+0.5j\omega+1)}{j\omega\,(0.1j\omega+1)(0.05j\omega+1)}$

$Y(j\omega) = 6/j\omega$

$|Y(j\omega)| = |20\log 6 - 20\log 0.1|$

$= 36$ dB

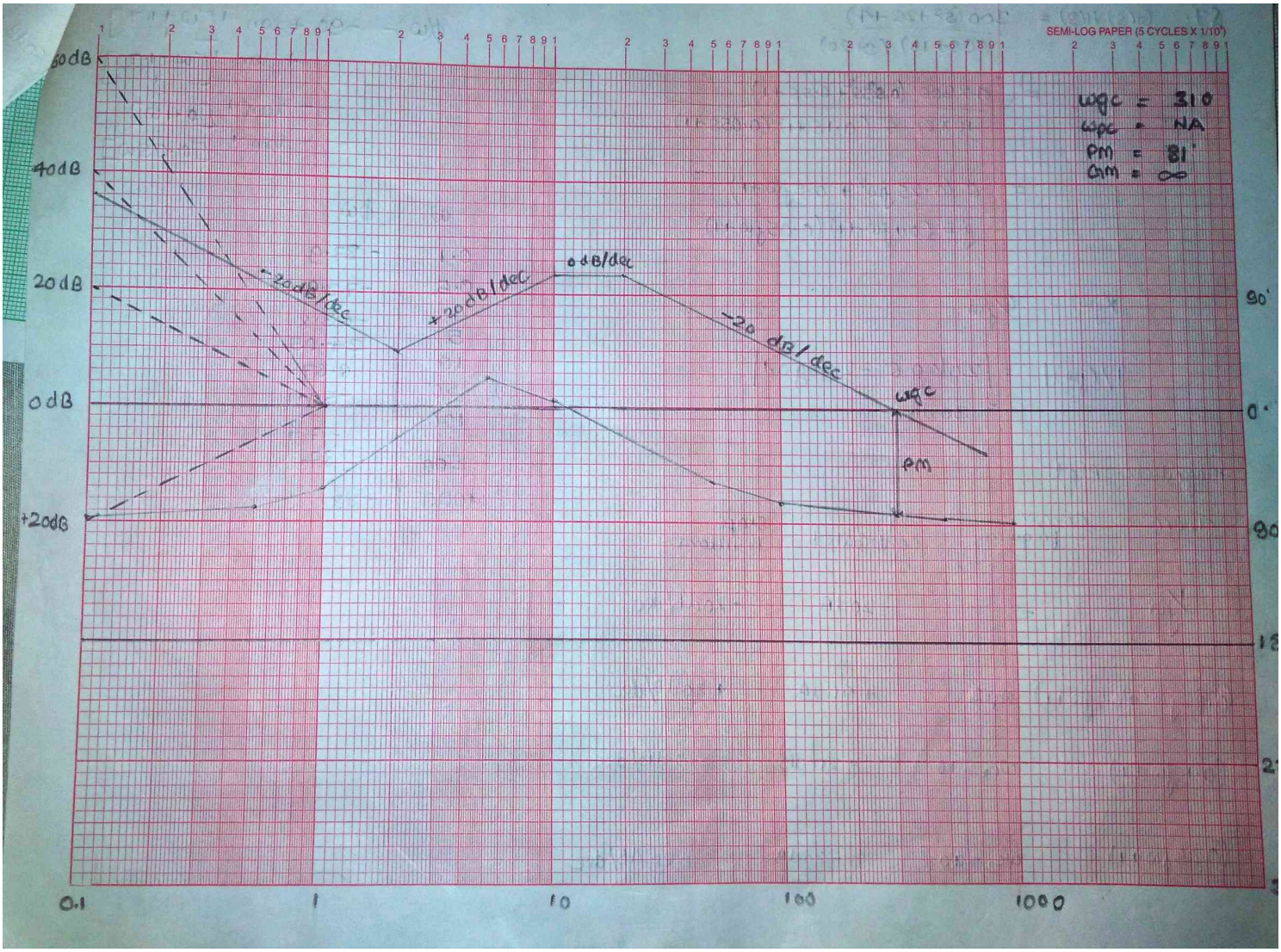
Magnitude Plot

Terms	Corner frequency	Slope contributed	Slope Resultant
$1/j\omega$	-	-20dB	-20dB/dec
$(0.25j\omega^2+0.5j\omega+1)$	$\omega_{C_1}=2$	+40dB	+20dB/dec
$(0.1j\omega+1)$	$\omega_{C_2}=10$	-20dB	0dB/dec
$(0.05j\omega+1)$	$\omega_{C_3}=20$	-20dB	-20dB/dec

Phase Plot:-

$\phi(\omega) = -90 + \tan^{-1}\left[\dfrac{\omega+1.7}{1}\right] + \tan^{-1}\left[\dfrac{\omega-1.7}{1}\right] - \tan^{-1}[0.1\omega] - \tan^{-1}[0.05\omega]$

ω	$\phi\omega$
0.1	-87.9
0.5	-78.9
1	-63.8
5	24.05
10	6.67
50	-59.1
100	-74
500	-87
1000	-88


SEMI-LOG PAPER (5 CYCLES X 1/10")
60dB
40dB
20dB
0dB
+20dB
-20dB/dec
+20dB/dec
0dB/dec
-20 dB/dec
ωgc
ϕm
ωgc = 310
ωpc = NA
ϕm = 81°
Gm = ∞
90°
0°
0.1
1
10
100
1000