higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CONTROL SYSTEMS N6

8 December 2023

This marking guideline consists of 9 pages.

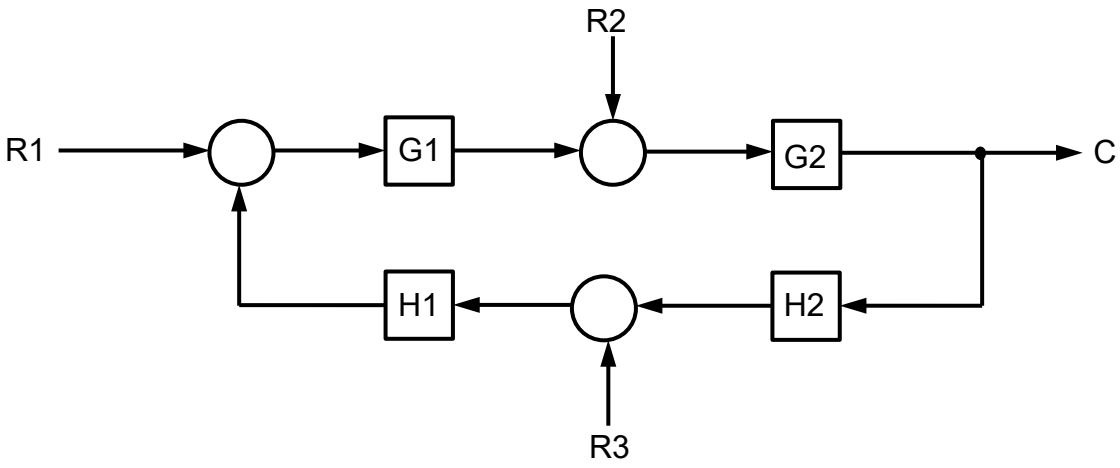
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QUESTION 1

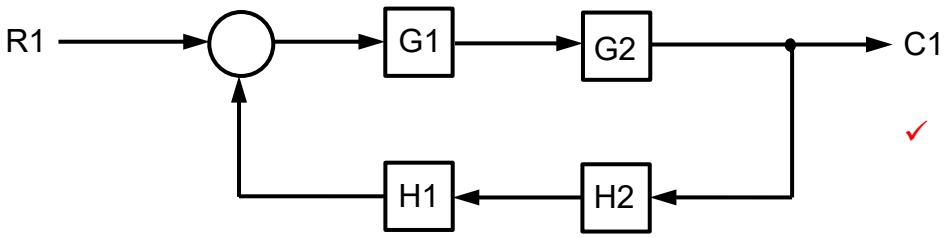
1.1 False
1.2 True
1.3 True
1.4 False
1.5 True
1.6 True
1.7 False
1.8 False
1.9 True
1.10 False

(10 × 1) **[10]**

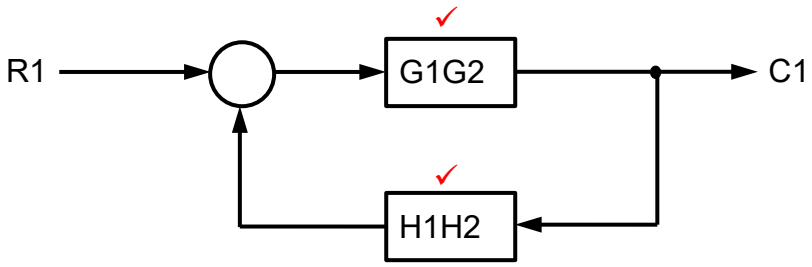
QUESTION 2



Let R2 and R3 = 0

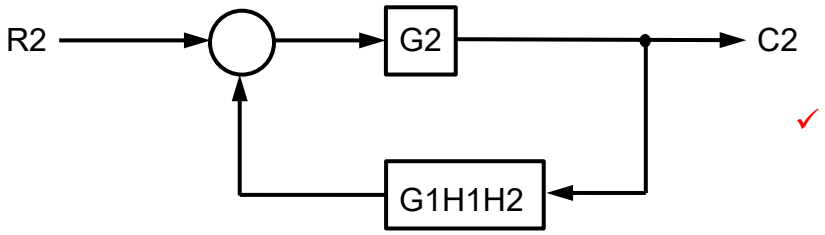


✓



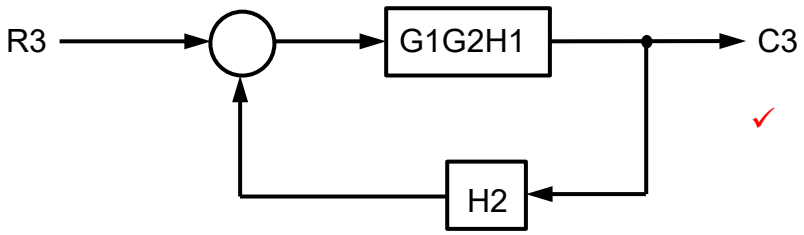
$$C1 = \frac{G1G2R1}{1 - G1G2H1H2}$$ ✓

Let R1 and R3 = 0



$$C2 = \frac{G2R2}{1 - G1G2H1H2}$$ ✓

Let R1 and R2 = 0



$$C3 = \frac{G1G2H1R3}{1 - G1G2H1H2}$$ ✓

$$C\ total = C1 + C2 + C3$$

$$= \frac{G1G2R1}{1 - G1G2H1H2} + \frac{G2R2}{1 - G1G2H1H2} + \frac{G1G2H1R3}{1 - G1G2H1H2}$$ ✓

$$C\ total = \frac{G1G2R1 + G2R2 + G1G2H1R3}{1 - G1G2H1H2}$$ ✓

[10]

QUESTION 3

$$G(s)H(s) = \frac{38{,}4 \times 12(s+1)}{s(s+1)(s+5)(s+10)}$$

$$= \frac{460{,}8}{s(s+5)(s+10)} \quad ✓$$

$$= \frac{9{,}216}{jw(1+\frac{jw}{5})(1+\frac{jw}{10})} \quad ✓$$

$$Gain\ Constant = 20\ Log\ 9{,}216$$
$$= 19{,}29\ dB ✓$$

See plot on graph paper✓✓✓✓✓✓✓ **[10]**

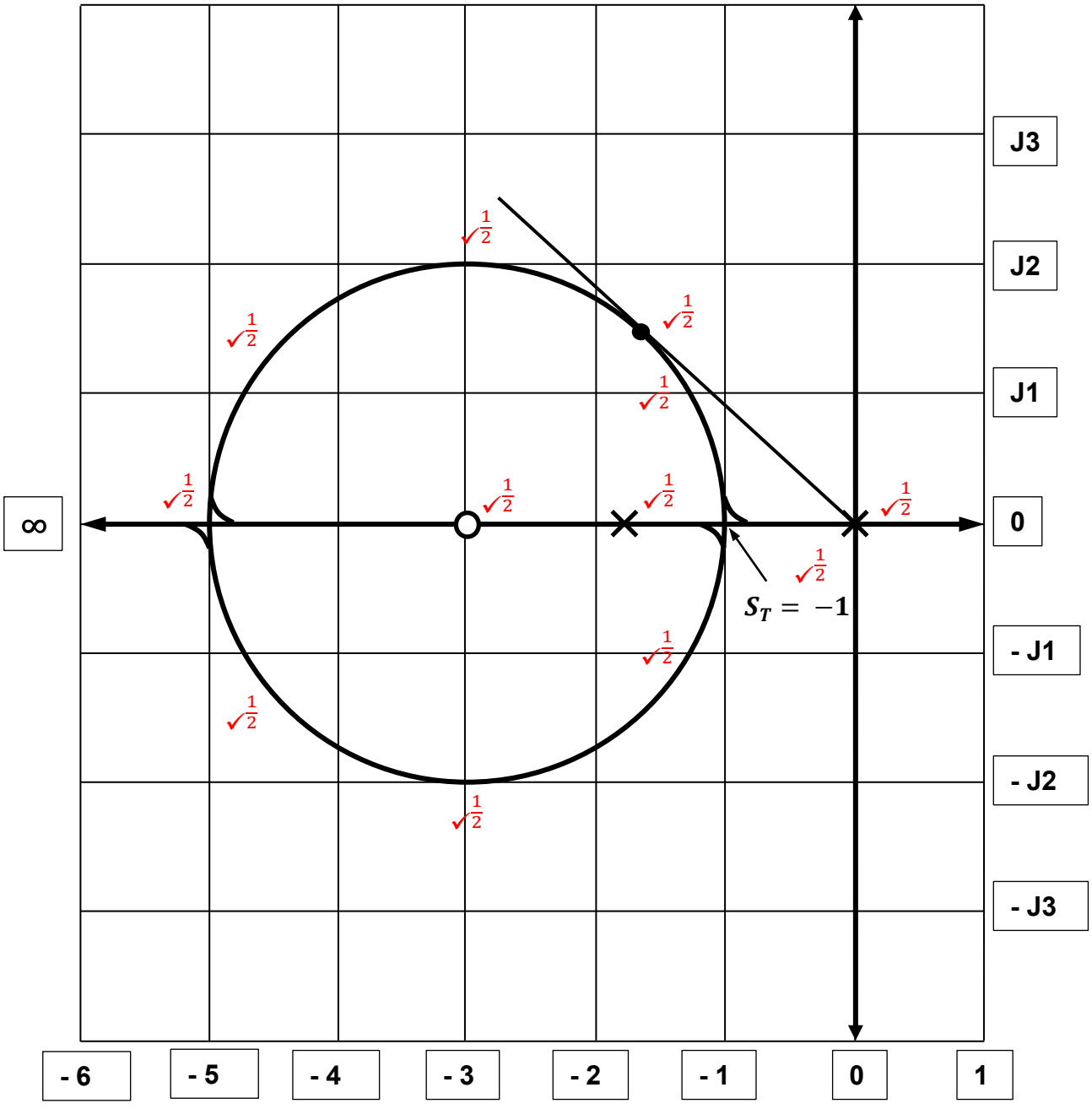
QUESTION 4

4.1	4.1.1	The gain margin = 16,4 dB✓	(1)
	4.1.2	The phase margin = 51,5°✓	(1)
	4.1.3	The gain crossover frequency = 56,67 rad/s✓	(1)
	4.1.4	The phase crossover frequency = 137,7 rad/s✓	(1)
	4.1.5	The un-damped natural resonant frequency = 99,2 rad/s✓	(1)
	4.1.6	The peak frequency response = 47,6 rad/s✓	(1)
	4.1.7	The peak magnitude and phase = 3 dB ✓ and – 45°✓	(2)
	4.1.8	The closed-loop bandwidth = 72,7 rad/s✓	(1)
4.2	Stable		(1)

[10]

QUESTION 5

5.1 See graph paper. ✓✓✓✓✓✓ (6)



5.2 5.2.1 $\omega_d = 1{,}5\ rad/s$ ✓ (1)

5.2.2 $\omega_n = 2{,}25\ rad/s$ ✓ (1)

5.2.3 ζ = cos θ
= cos 42,5° ✓
= 0,737 ✓ (2)

[10]

QUESTION 6

6.1 6.1.1 $f(x) = 12cos3t$

$$X(s) = \frac{12s}{s^2 + 3^2}$$ (1)

6.1.2 $f(x) = 12(t)$

$$X(s) = \frac{12}{s}$$ (1)

6.1.3 $F(t) = 30(1 - e^{\frac{-t}{3}})$

$$= \frac{A}{s(\tau s + 1)}$$

$$F(s) = \frac{30}{s(3s + 1)}$$ (2)

6.2 6.2.1 $$F(s) = \frac{24}{(s + 4)^2}$$

$$f(t) = 24te^{-4t}$$ (1)

6.2.2 $$F(s) = \frac{15\omega}{(s^2 + \omega^2)(s + 5)}$$

$$= \frac{15\omega e^{-5t}}{(\omega^2 + 5^2)} + \frac{15}{\sqrt{\omega^2 + 5^2}}\sin(\omega t - \Psi) \; where \; \tan^{-1}\frac{\omega}{5}(0 < \Psi < \pi)$$ (2)

6.2.3 $$F(s) = \frac{42}{(4s + 1)(2s + 1)}$$

$$F(t) = \frac{A}{\tau_1 - \tau_2}\left[e^{\frac{-t}{\tau_1} - \frac{-t}{\tau_2}}\right]$$

$$F(t) = \frac{42}{4-2}\left[e^{\frac{-t}{4} - \frac{-t}{2}}\right] \quad ✓$$

$$F(t) = \frac{42}{2}\left[e^{\frac{-t}{4} - \frac{-t}{2}}\right] \quad ✓$$

$$F(t) = 21\left[e^{\frac{t}{4}}\right] \quad ✓$$ (3)

[10]

QUESTION 7

7.1 A – Inverting input
B – Non-inverting input
C – Output (3)

7.2 They are used for:
- Adding
- Subtracting
- Multiplying
- Dividing
- Differentiating
- Integrating (Any 4 × 1) (4)

7.3
- A transmitter
- A medium
- An optical receiver (3)

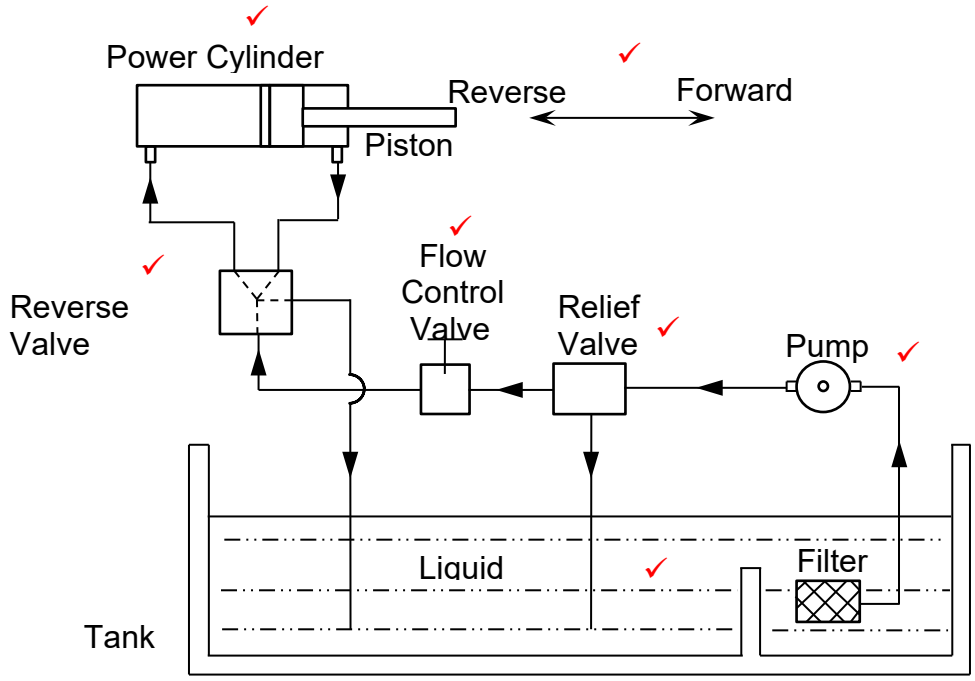
[10]

QUESTION 8

8.1
- Rotary vane actuator
- Rack-and-pinion actuator (2)

8.2 Derivative control – it controls the rate of the error in respect of time. (1)

8.3



BASIC HYDRAULIC SYSTEM, RECIPROCATING MACHINE TOOL (7)

[10]

QUESTION 9

9.1
- Proportional control
- Integral control
- Differential or derivative control (3)

9.2
- Correction is made which is proportional to the time integral of the error
- Correction is made at a rate proportional to the error until the error is zero

(Any ONE) (2)

9.3
- The system is not accurate
- There are only two fixed positions or outputs (2)

9.4
- It is difficult to lubricate moving parts
- A compressed air pipe system is required throughout the plant
- The motion of components are unpredictable due to the compressibility of air (3)

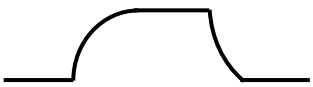
[10]

QUESTION 10

10.1 Lissajous figures are usually used for determining the frequency of unknown sinusoidal signals. (2)

10.2 Impedance mismatching (1)

10.3 10.3.1



10.3.2



10.3.3



(3 × 1) (3)

10.4 A saw-tooth wave can be generated by charging and discharging a capacitor using proper RC time constants. (2)

10.5 $p.r.f = \frac{1}{Period}$

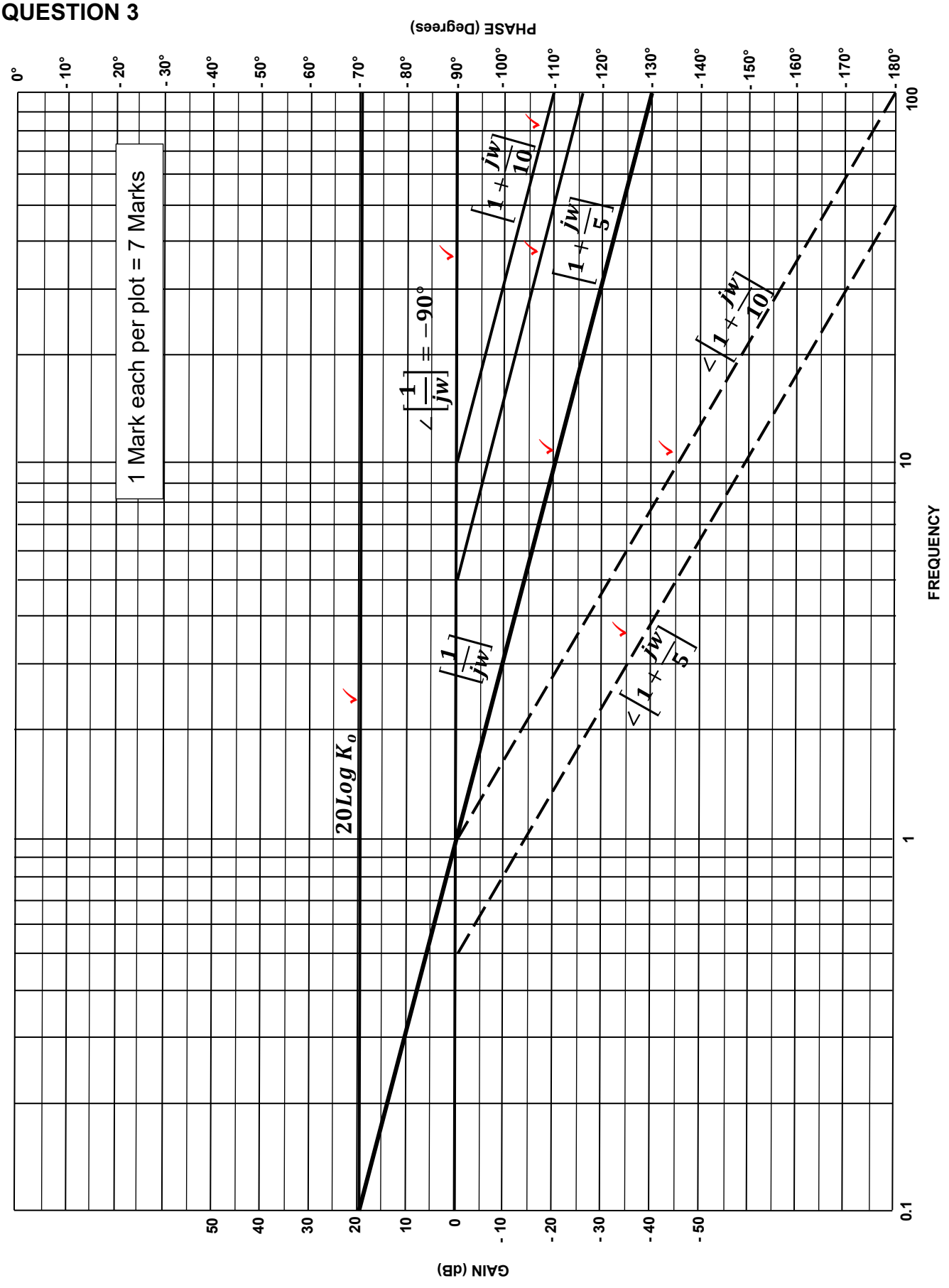
$p.r.f = \frac{1}{5 \times 10^{-6}}$ ✓

$p.r.f = 200\,000\ pulses/sec$ ✓ (2)

[10]

TOTAL: 100

QUESTION 3



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