



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

**NATIONAL CERTIFICATE
CONTROL SYSTEMS N6**

13 August 2021

This marking guideline consists of 8 pages.

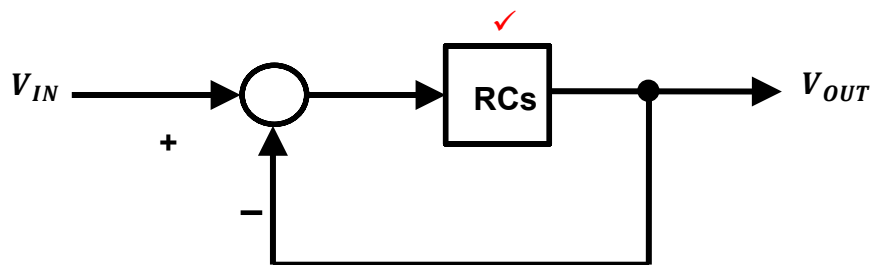
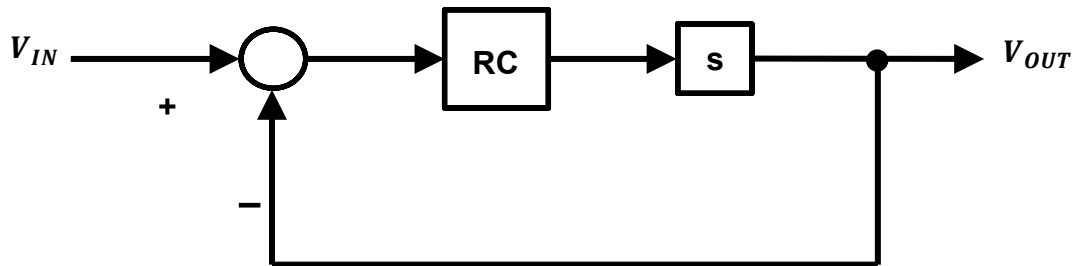
QUESTION 1

- 1.1 Control system
- 1.2 Unit step function
- 1.3 Disturbance
- 1.4 Total response
- 1.5 Transfer function
- 1.6 Impulse function
- 1.7 System gain factor
- 1.8 Resonance frequency
- 1.9 Damping factor
- 1.10 Drift

(10 × 1) [10]

QUESTION 2

2.1



$$\frac{V_O}{R_{IN}} = \frac{G}{1 \pm GH} \checkmark$$

$$\frac{V_O}{R_{IN}} = \frac{RCs}{1 + RCs} \checkmark\checkmark$$

$$\frac{V_O}{R_{IN}} = \frac{\tau s}{1 + \tau s} \checkmark$$

(5)

2.2 $F(t) = 4 \sin 3t$

$$F(s) = \frac{A\omega}{s^2 + \omega^2}$$

$$= \frac{4 \times 3}{s^2 + 3^2} \checkmark$$

$$F(s) = \frac{12}{s^2 + 9} \checkmark \quad (2)$$

2.3 $F(s) = \frac{32}{S(S+2)(S+4)}$

$$F(t) = \frac{A}{ab} \left[1 + \frac{ae^{-bt} - be^{-at}}{b - a} \right]$$

$$= \frac{32}{2 \times 4} \left[1 + \frac{2e^{-4t} - 4e^{-2t}}{4 - 2} \right] \checkmark \checkmark$$

$$F(t) = 4 [1 + e^{-4t} - 2e^{-2t}] \checkmark \quad (3)$$

[10]

QUESTION 3

3.1 See graph on 3-cycle semi logarithmic graph paper below. (5)

3.2 3.2.1 There is no phase crossover frequency – the phase plot does not cross the -180° line.

3.2.2 8 rad/s

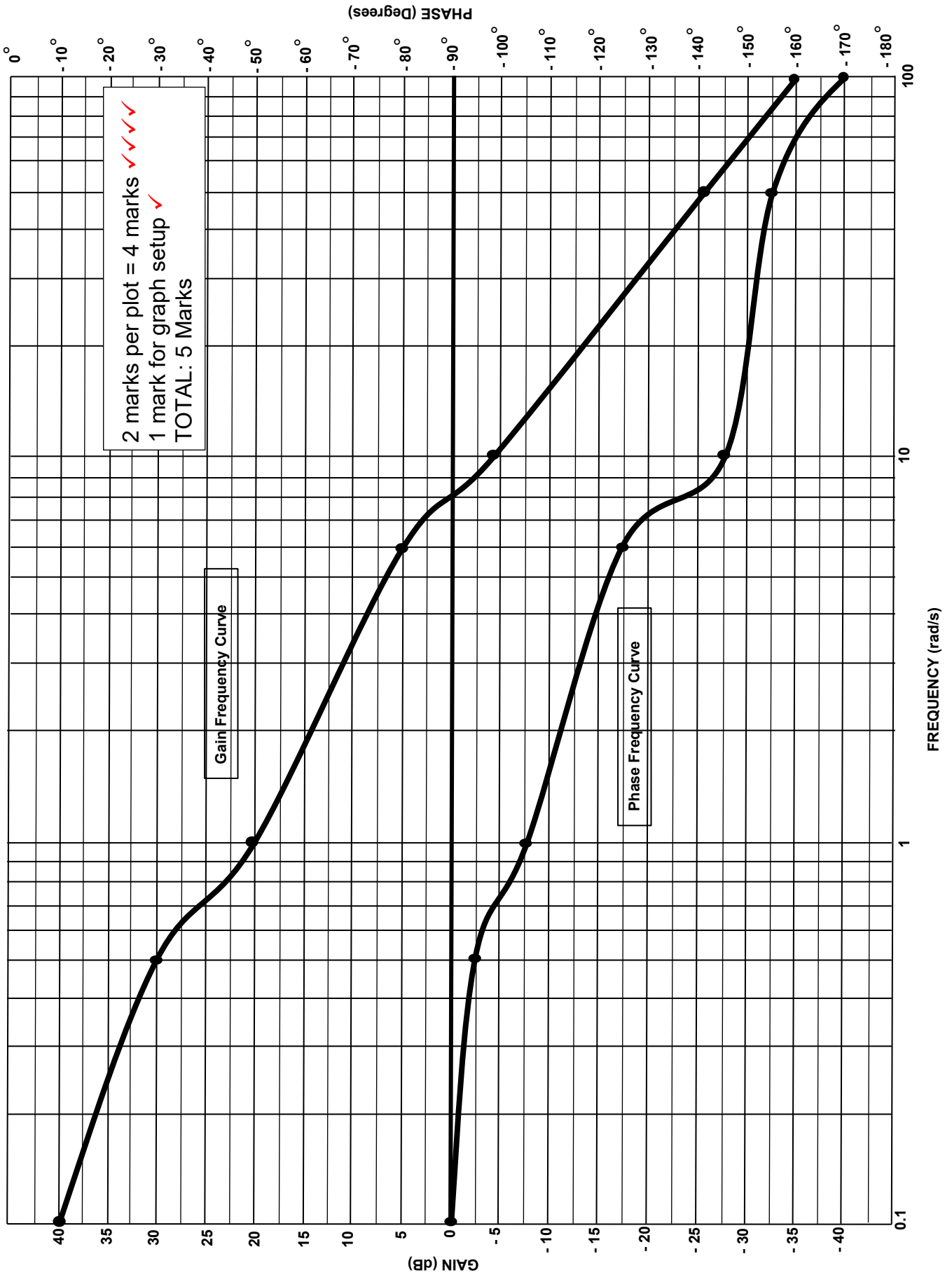
3.2.3 0,1 rad/s

3.2.4 43°

3.2.5 The gain margin is not determinable due to not having a phase crossover frequency

(5 × 1) (5)
[10]

QUESTION 3.1



2 marks per plot = 4 marks ✓✓✓✓
1 mark for graph setup ✓
TOTAL: 5 Marks

Gain Frequency Curve

Phase Frequency Curve

QUESTION 4

4.1	4.1.1	12.7 dB	(1)
	4.1.2	43°	(1)
	4.1.3	30.5 rad/s	(1)
	4.1.4	42.5 rad/s	(1)
	4.1.5	32 rad/s	(1)
	4.1.6	30.5 rad/s	(1)
	4.1.7	3 dB and – 72° ✓✓	(2)
	4.1.8	38 rad/s	(1)
4.2	Stable		(1)
			[10]

QUESTION 5

5.1	<ul style="list-style-type: none"> • 0 • -12 	(2)
5.2	$\Delta_{p1} = 4.5$ Distance from Pole 0 to D ✓ $\Delta_{p2} = 7.2$ Distance from Pole 12 to D ✓ $K_o = \frac{\Delta_{p1}\Delta_{p2}}{1}$ $= \frac{4.5 \times 7.2}{1}$ $K_o = 32.4 \quad \checkmark$	(3)
5.3	$\omega_d = 3,95 \text{ rad/s} \quad \checkmark$	(1)
5.4	$\omega_n = 4,5 \text{ rad/s} \quad \checkmark$	(1)
5.5	$\zeta = \cos \theta$ $= \cos 63^\circ \checkmark$ $= 0,55 \checkmark$	(2)
5.6	The system will not become unstable as it does not cross the $j\omega$ axis	(1)
		[10]

QUESTION 6

- 6.1
- Infinite input impedance
 - Zero output impedance
 - Infinite bandwidth
 - Zero open-loop voltage
 - Zero voltage off-set
- (5)
- 6.2 It converts information-bearing light variations into electrical signals. (2)
- 6.3 It is used for speed regulation in a closed-loop control system. (2)
- 6.4 Tacho-generators measure angular velocity. (1)
- [10]**

QUESTION 7

- 7.1
- It assists in changing the motor direction
 - It regulates the power output with the aid of a thyristor
- (2)
- 7.2
- A fixed input voltage is supplied to both the input and output potentiometers
 - With both potentiometer rotors in the same position, the system is at rest (error signal = 0)
 - The rotor of the input potentiometer is set at an angle mechanically.
 - This misalignment between input and output rotors result in an error voltage being applied to the amplifier.
 - The error signal is amplified and adjusts the motor to turn the load accordingly while turning the rotor of the output potentiometer.
 - The error will be continuously corrected until the rotor of the input and output potentiometers are aligned correctly.
- (6)
- 7.3
- Light dependent resistor
 - Light dependent diode
 - Light dependent transistor or thyristor
- (Any 2 × 1) (2)
- [10]**

QUESTION 8

- 8.1
- It is accurate
 - It is economical
 - It is efficient and dependable
 - It is readily available
 - It gives predictable performance
 - It is simple and easy to install and maintain
 - It provides freedom in machine design
 - It gives fast response to controls
 - It provides flexibility in the control of machines
 - It is compatible with most controls, i.e. electrical, electronic or mechanical
 - It provides constant torque at infinity variable speeds in both directions with smooth reversal
 - It provides an efficient method of multiplying forces
 - It can amplify small forces to control large loads
 - It automatically lubricates oil fluid power
 - Air fluid power is clean and safe from fire hazards
- (Any 6 × 1) (6)
- 8.2
- A drive gear is in mesh with a driven gear.
 - As the teeth of both gears unmesh, a vacuum is created at the inlet side of the pump and atmospheric pressure forces the liquid into the spaces between the teeth.
 - The rotating gears move the liquid along the outside of the gears towards the outlet of the pump.
 - At the outlet side, pressure is created due to the meshing of gears and fluid is forced out of the pump.
- (4)

[10]**QUESTION 9**

- 9.1
- Proportional control
 - Integral control
 - Differential or derivative control
- (3)
- 9.2
- Correction is made at a rate proportional to the error until the error is zero
 - Correction is made which is proportional to the time integral of the error
- (Any ONE) (2)
- 9.3
- It decreases the response time and makes the system sluggish
 - It tends to destabilise the system and make it more sensitive to steady errors
 - If the gain factor is an incorrect value, the output pressure will have a constant offset
 - The size of the amplifying constant may not be high enough to achieve the desired response
- (Any 2 × 1) (2)

- 9.4 Steady State is a condition where the input signal is a constant value and the output has stabilised by levelling out at a constant value or reaching a constant rate of change.

OR

Steady State is a condition where the input signal is a constant amplitude cycle such as a sine wave and the output signal has also become a constant amplitude cycle.

(3)
[10]

QUESTION 10

- 10.1
- Straight line
 - Circle
 - Ellipse
- (3)
- 10.2 A pulse generator is a device that produces a stream of pulses at regular intervals.
- (2)
- 10.3
- Apply a test signal to initiate a changing manipulated variable to the final control element
 - Connect a signal generator to the system
 - Record the system response onto a suitable recorder
- (3)
- 10.4
- Moving iron
 - Moving coil
- (2)
[10]

TOTAL: 100