higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CONTROL SYSTEMS N6

2 December 2022

This marking guideline consists of 8 pages.

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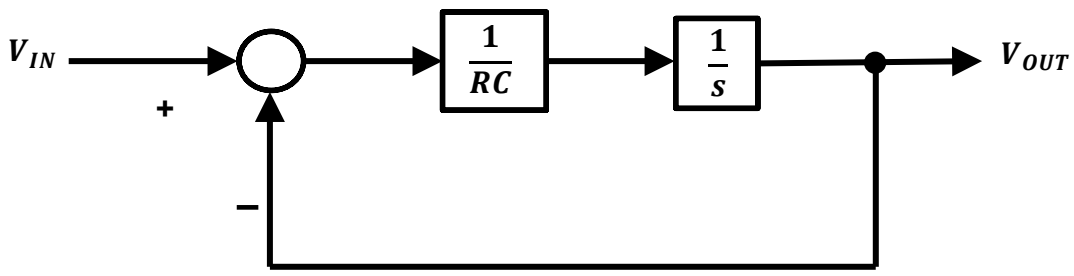
QUESTION 1

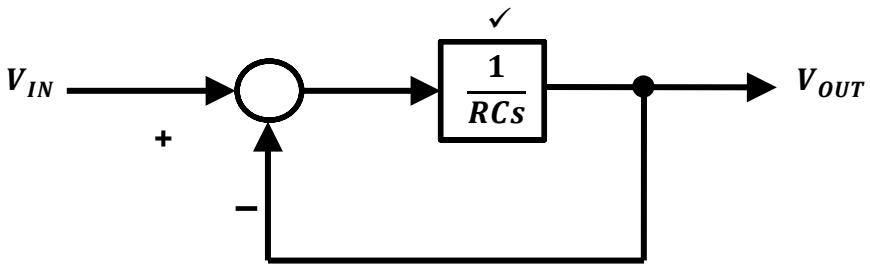
1.1 True
1.2 True
1.3 False
1.4 False
1.5 True
1.6 False
1.7 True
1.8 False
1.9 True
1.10 True

(10 × 1) **[10]**

QUESTION 2

2.1





✓

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

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

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

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

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

(6)

2.2 $$\mathrm{F}(s) = \frac{135}{(3s+1)^2}$$

$$F(t) = \frac{At}{\tau^2}\ \left[e^{\frac{-t}{\tau}}\right]$$

$$= \frac{135t}{3^2}\ \left[e^{\frac{-t}{3}}\right] ✓$$

$$F(t) = 15te^{\frac{-t}{3}}\ ✓$$ (2)

2.3 $$F(t) = 15\left[1 - \frac{(3+t)}{3}\ e^{\frac{-t}{3}}\right]$$

$$F(s) = \frac{15}{s(3+a)^2}\ ✓✓$$ (2)

[10]

QUESTION 3

3.1 The gain peak value (Mp): 22 dB (1)

3.2 The TWO corner frequencies: 1 rad/s✓ and 5 rad/s✓ (2)

3.3 The gain crossover frequency (ω_1): 7,7 rad/s✓ (1)

3.4 The phase crossover frequency (ω_π): 1,8 rad/s✓ (1)

3.5 The resonant frequency (ω_p): 1 rad/s✓ (1)

3.6 The gain margin: -18,5 dB✓ (1)

3.7 The phase margin: -53°✓ (1)

3.8 The system is unstable – the gain margin exceeds unity when the phase crosses over and the phase margin is more than -180° when the gain crosses over.

OR

The gain and phase margins are negative, thus ensuring instability in the system. (2)

[10]

QUESTION 4

4.1

ω (rad/sec)	25	50	90	150
Magnitude in dB	- 0,25	0,1	1,5	-5
Phase in degrees	-2°	-6°	-15°	-190°
	✓	✓	✓	✓

(4)

4.2 4.2.1 The gain margin = 7,8 dB

4.2.2 The phase crossover frequency = 145°

4.2.3 The un-damped resonant frequency = 124,5 dB

4.2.4 The bandwidth = 146 rad/s

4.2.5 The peak magnitude gain value = 4,75 dB

4.2.6 The peak magnitude phase value = -100°

(6 × 1) (6)

[10]

QUESTION 5

5.1 The denominator = $S^2 + 4S + 5A$

$$S = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$= \frac{-(4) \pm \sqrt{4^2 - 4(1)(5\mathrm{A})}}{2(1)}$$

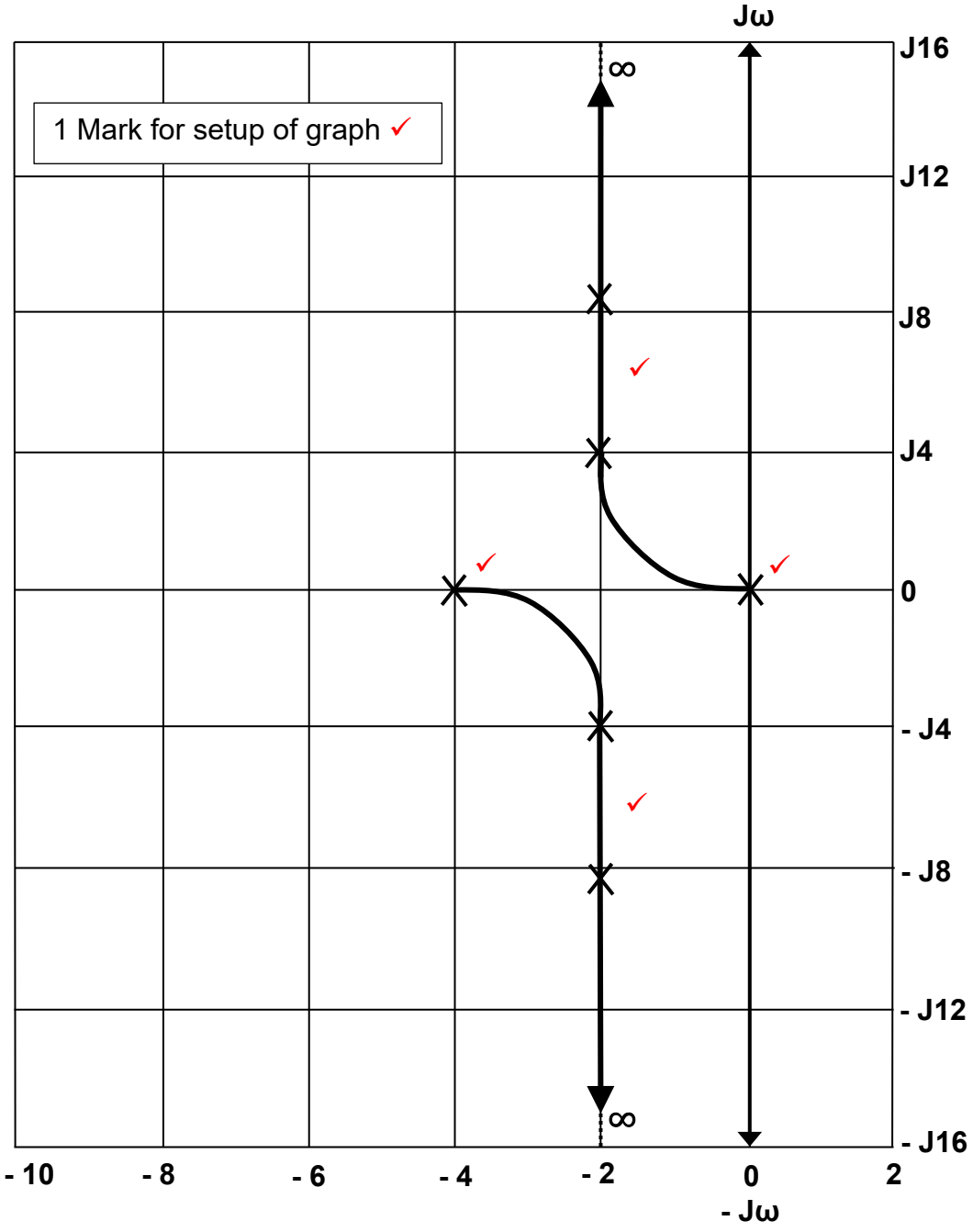
$$= -2 \pm \frac{\sqrt{16 - 20\mathrm{A}}}{2} \checkmark$$

✓ ✓ ✓ ✓

A	0	4	16	∞
S_1	0	- 2 + j4	- 2 + j8.718	- 2 + j∞
S_2	- 4	- 2 – j4	- 2 – j8.718	- 2 - j∞

(5)

5.2

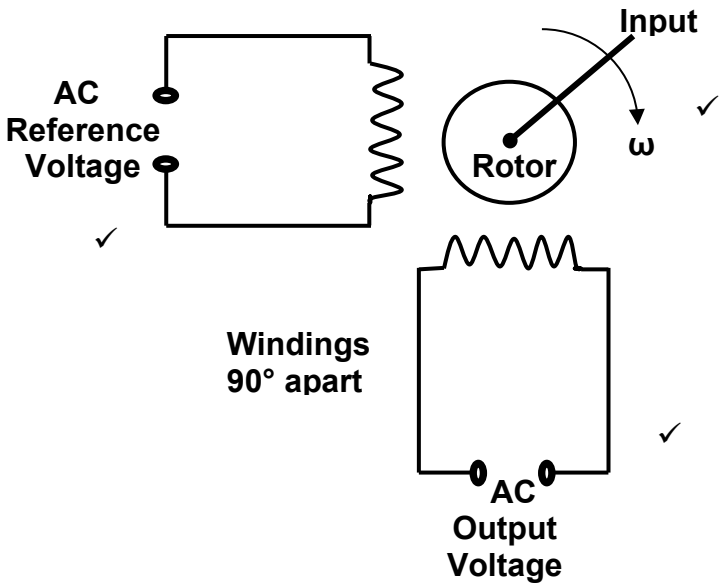

Jω
J16
J12
J8
J4
0
- J4
- J8
- J12
- J16
∞
∞
- 10
- 8
- 6
- 4
- 2
0
2
- Jω
1 Mark for setup of graph ✓

(5)
[10]

QUESTION 6

6.1
- Resistive
- Inductive
- Capacitive
- Light-sensitive type (4)

6.2



AC Tachogenerator (3)

6.3 It is the voltage between adjacent turns of wire divided by the input voltage. (2)

6.4 Photoelectric transducer (1)
[10]

QUESTION 7

7.1 It converts one form of energy into another, e.g., mechanical energy into electrical energy or vice versa. (2)

7.2
- The DC output voltage must be proportional to the r.m.s. value of the AC signal.
- The polarity of the DC output must be phase sensitive. (2)

7.3
- Hydraulic systems
- Pneumatic systems (2)

7.4
- The output-input relationship is not precisely linear.
- Wear produced by sliding action reduces the life of potentiometers. (2)

7.5 Is used for the remote position control of artillery guns and radar turrets. (2)
[10]

QUESTION 8

8.1
- Spur gear
- Helical gear
- Herringbone gear (Any 2 × 1) (2)

8.2 8.2.1 Vane-type pump (1)

8.2.2 A – Inlet port
B – Outlet port
C – Vane/Blade (3)

8.2.3
- As the rotor turns, a vacuum is created at the inlet side of the pump and fluid is sucked in.
- The sliding vanes, which slide in the rotor, move outwards due to a centrifugal force.
- The centrifugal force and pressure keep the vanes in contact with the casing as the vanes move the fluid along the cavity of the pump in the direction of rotation.
- At the outlet, the cavity gets smaller and the pressure increases, which causes the fluid to be exited with a force. (4)

[10]

QUESTION 9

9.1
- It can operate at very high temperatures.
- It exhausts air into the atmosphere.
- It is highly compressible.
- It is much faster.
- It is suitable for fire-risk areas.
- Cheaper operating costs.
- It is clean.
- Is easily available. (Any 6 × 1) (6)

9.2 Derivative control is used to speed up the response time of the corrective action before the error gets too large. (2)

9.3
- System has a steady-state error
- System is sluggish (2)

[10]

QUESTION 10

10.1
- Square wave
- Triangular wave
- Saw-tooth wave (3)

10.2
- Analog voltmeters
- Digital voltmeters (2)

10.3
- If a sinusoidal current is passed through the system, the voltage is also sinusoidal.
- It gives much more useful information when used to test circuits.
- It helps us to predict how a circuit would respond to various frequencies. (3)

10.4
- Gain margin
- Phase margin (2)

[10]

TOTAL: 100

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