



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

**NATIONAL CERTIFICATE
CONTROL SYSTEMS N6**

20 April 2020

This marking guideline consists of 8 pages.

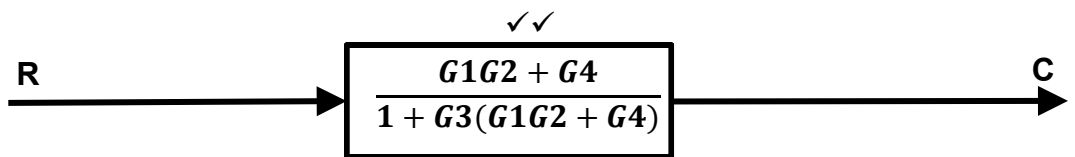
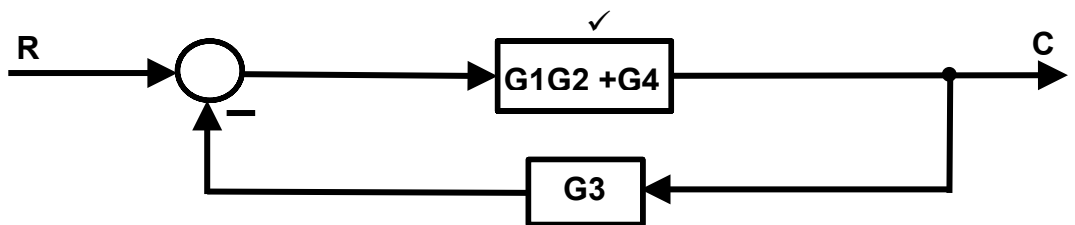
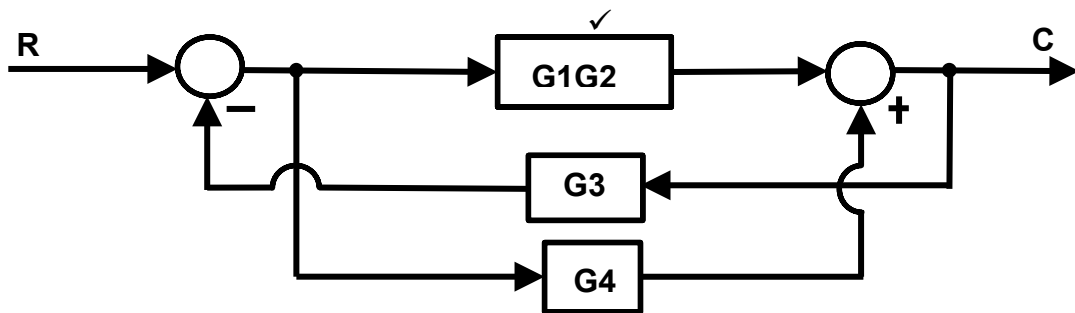
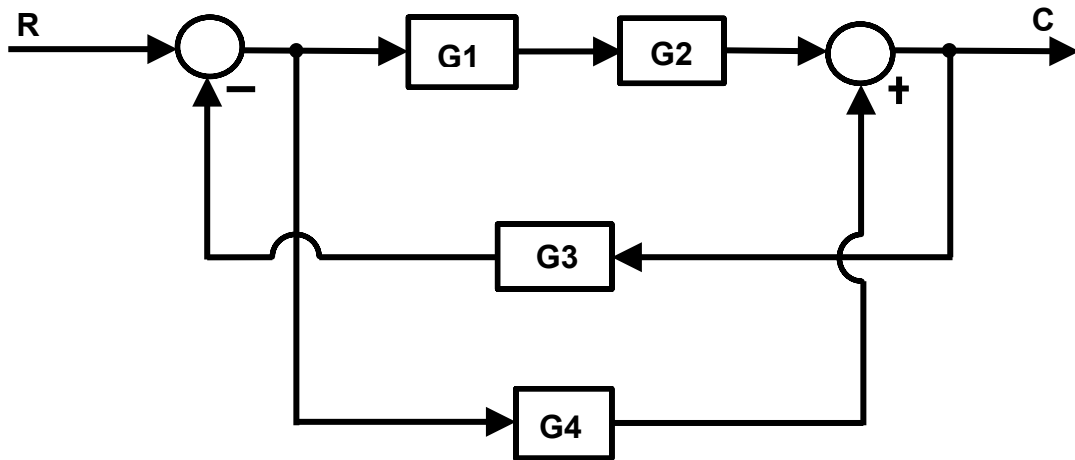
QUESTION 1

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

(10 × 1) **[10]**

QUESTION 2

2.1



$$\frac{C}{R} = \frac{G1G2 + G4}{1 + G3(G1G2 + G4)} \quad \checkmark$$

$$C = \frac{R(G1G2 + G4)}{1 + G3(G1G2 + G4)} \quad \checkmark$$

(6)

$$2.2 \quad \frac{40}{(s+4)(s+5)} \rightarrow$$

$$\frac{40}{(5-4)} [e^{-4t} - e^{-5t}] \quad \checkmark\checkmark \quad (2)$$

$$2.3 \quad \frac{15}{100} (e^{-10t} + 10t - 1) \rightarrow$$

$$\frac{15}{s^2(s+10)} \quad \checkmark\checkmark \quad (2)$$

[10]

QUESTION 3

- 3.1 Gain crossover frequency: 1.75 rad/s ✓ (1)
- 3.2 Phase crossover frequency: 15 rad/s ✓ (1)
- 3.3 Phase margin: 47° ✓ (1)
- 3.4 Gain = 43 dB ✓
Phase = 174° ✓ (2)
- 3.5 Gain corner frequencies: 1.5 rad/s ✓
4 rad/s ✓ (2)
- 3.6 Gain cut-off rates: - 39 dB/decade or - 13dB/ octave ✓
- 75 dB/decade or - 23dB/ octave ✓
- 32 dB/decade or - 11dB/ octave ✓ (3)
- [10]**

QUESTION 4

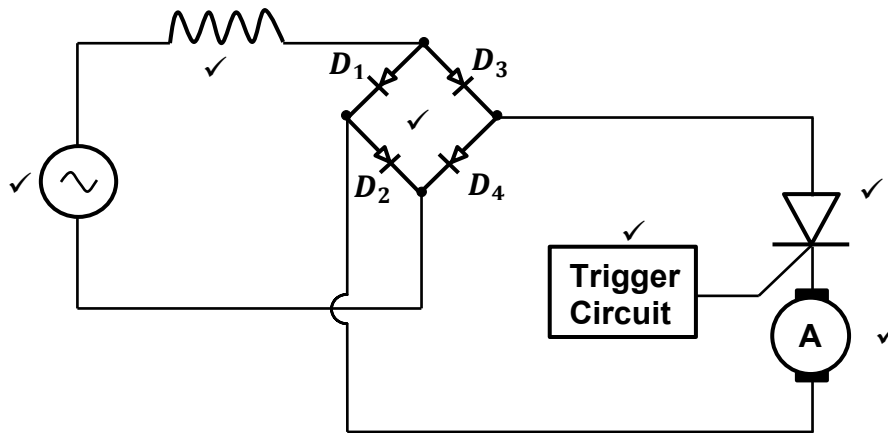
- 4.1 See attached diagram of QUESTION 4.1. ✓✓✓✓✓ (5)
- 4.2 4.2.1 Gain margin: 15.3 dB
 4.2.2 Phase margin: 34°
 4.2.3 Gain crossover frequency: 10 rad/s
 4.2.4 Phase crossover frequency: 19.9 rad/s
 4.2.5 Un-damped natural resonant frequency: 11.1 rad/s
- (5 × 1) (5)
[10]

QUESTION 5

- 5.1 Poles = 0 ✓ & - 6 ✓
Zeros = - 9 ✓ (3)
- 5.2 Smallest value of the damping ratio: $\zeta = \cos \theta$
 $= \cos 42^\circ$ ✓
 $= 0.743$ ✓ (2)
- 5.3 Damped resonant frequency ' ω_d ': $\omega_d = 4.5$ rad/sec (1)
- 5.4 Undamped resonant frequency ' ω_n ': $\omega_n = 6.67$ rad/sec (1)
- 5.5 Gain constant ' K_o ':
- $$\Delta P_1 = 4.67$$
- $$\Delta P_2 = 6.67$$
- $$K_o = \frac{\Delta P_1 \Delta P_2}{\Delta Z_1}$$
- $$= \frac{4.67 \times 6.67}{6} \checkmark$$
- $$K_o = 5.19 \checkmark \quad (2)$$
- 5.6 The system does not become unstable due to the loci not crossing the imaginary axis. (1)
[10]

QUESTION 8

8.1



Reversible half-wave universal speed control circuit (6)

8.2 Feedback – Is to monitor the plant’s output performance and relay the message back to the controller to make the necessary changes if required. (2)

- 8.3
- Stability
 - Speed of response
 - Steady state error
- (Any 2 × 1) (2)
[10]

QUESTION 9

- 9.1
- Internal spur gear pump
 - External spur gear pump
- (2)

9.2 9.2.1 Radial action piston pump (1)

- 9.2.2
- A – Inlet and outlet ports
 - B – Pistons
 - C – Cylinder block
- (3)

- 9.2.3
- The pistons at the inlet port move outwards in the cylinder creating a vacuum which causes the fluid to be sucked into the cylinder cavity.
 - The pistons at the outlet port move inwards causing a decrease in volume and an increase in pressure which forces the fluid out the pump.
- (2 +2) (4)
[10]

QUESTION 10

10.1	10.1.1	Proportional control		
	10.1.2	Integral control	(2 × 1)	(2)
10.2		Increase in the gain of a system and causes the response to oscillate		(1)
10.3		<ul style="list-style-type: none">• When deviation occurs the flapper is moved either towards or away from the nozzle.✓• If the flapper moves towards the nozzle, the nozzle back pressure increases and exerts a force inside the bellows causing it to expand which in turn moves the flapper away from the nozzle against the deviation.✓✓• If the flapper moves away from the nozzle, the nozzle back pressure decreases and no force is exerted inside the bellows causing it to contract which in turn moves the flapper towards the nozzle against the deviation.✓✓• There is some movement if the nozzle is cancelled and the gain of the controller is reduced.✓• The bellows make the output pressure change in such a way that it is directly proportional to the deviation.✓		(7)
			TOTAL:	100

QUESTION 4.1

