higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CONTROL SYSTEMS N6

13 APRIL 2018

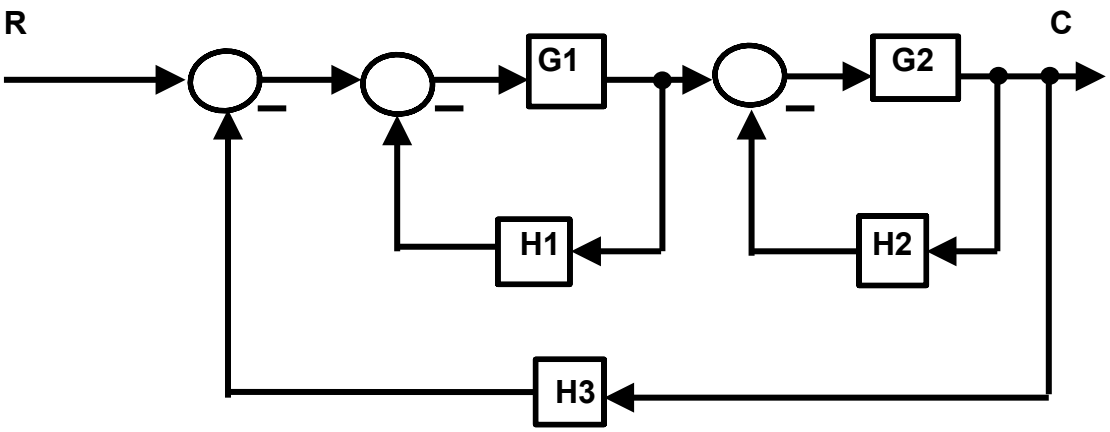
This marking guideline consists of 7 pages and 1 diagram sheet.

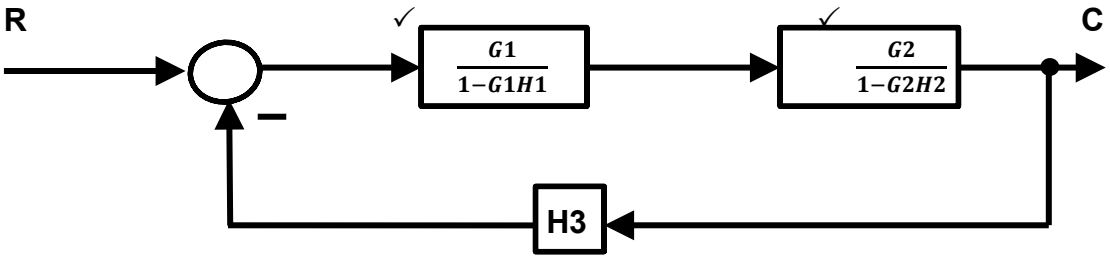
QUESTION 1

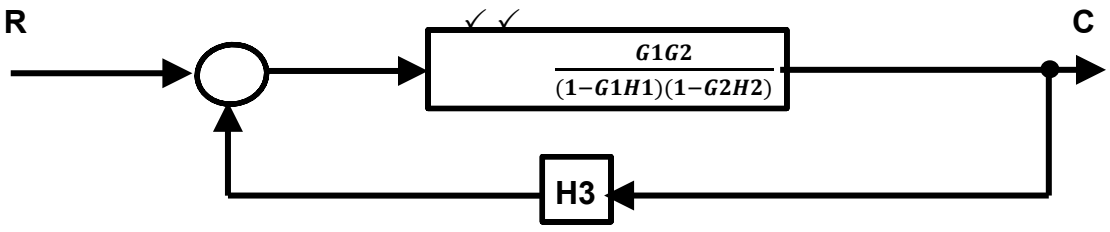
1.1 F
1.2 E
1.3 D
1.4 H
1.5 A
1.6 I
1.7 B
1.8 J
1.9 C
1.10 G

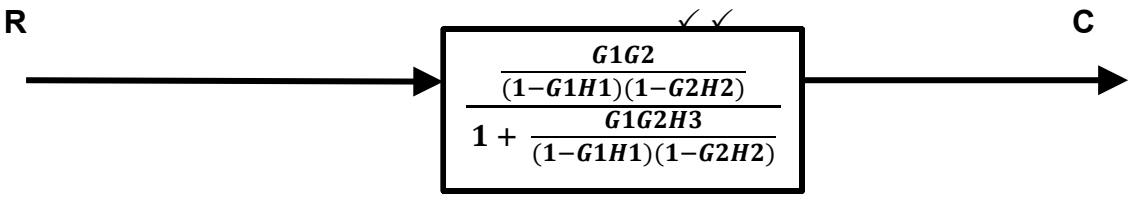
(10 × 1) **[10]**

QUESTION 2









$$\frac{C}{R} = \frac{\frac{G1G2}{(1-G1H1)(1-G2H2)}}{\frac{(1-G1H1)(1-G2H2)+G1G2G3}{(1-G1H1)(1-G2H2)}} \quad ✓✓$$

$$\frac{C}{R} = \frac{G1G2}{(1-G1H1)(1-G2H2)} \times \frac{(1-G1H1)(1-G2H2)}{(1-G1H1)(1-G2H2)+G1G2G3} \quad ✓$$

$$\frac{C}{R} = \frac{G1G2}{(1-G1H1)(1-G2H2)+G1G2G3} \quad ✓$$

[10]

QUESTION 3

3.1 28 dB (1)

3.2 – 255° (1)

3.3 8 rad/s (1)

3.4 – 52 dB per decade or – 25 dB per octave (1)

3.5 65 r/s (1)

3.6 55 r/s (1)

3.7 – 12 dB (1)

3.8 – 22° (1)

3.9 The gain and phase margins are negative, thus indicating an unstable system. (2)

(10 × 1) **[10]**

QUESTION 4

4.1 See attached diagram on DIAGRAM SHEET 1. (6)

4.2 4.2.1 Gain margin = 7 dB

4.2.2 Phase margin = 20º

(2 × 1) (2)

4.3 Additional gain: 10dB – 7dB = 3 dB ✓
Factor: $10^{\frac{3}{20}} = 1{,}413$ ✓ (2)
[10]

QUESTION 5

5.1 Open-loop poles = 0 ; – 2 ; – 8 ✓ Zeros = – 4 ✓ (2)

5.2 Yes. The segment of locus is bounded by two poles which cause a breakaway point. ✓✓ (2)

5.3
$$S_c = \frac{\sum Poles - \sum Zeros}{N_p - N_z}$$
$$= \frac{(0-2-8)-(-4)}{3-1} \quad \checkmark$$
$$= \frac{-6}{2}$$
$$S_c = -3 \checkmark$$
(2)

5.4
$$\psi = \frac{(2K+1)180}{N_p - N_z}$$
$$= \frac{(2K+1)180}{2} \; if \; \mathrm{K} = 0, 1, 2, 3, \infty \quad \checkmark$$
$$\psi = 90° \; when \; K = 0 \quad \checkmark$$
$$\psi = 270° \; when \; K = 1$$
(2)

5.5 The system is stable as the loci angles are in a straight line. (2)
[10]

QUESTION 6

6.1 6.1.1 $T_A = 10\sin 4t = A\sin\omega t$ ✓

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

6.1.2 $\frac{Output}{Input} = \frac{\omega_n^2}{s^2+4\zeta\omega_n s+\omega_n^2}$

$\frac{Output}{T_A} = \frac{\omega_n^2}{s^2+4\zeta\omega_n s+\omega_n^2}$ ✓

$Output_s = \frac{T_A\omega_n^2}{s^2+4\zeta\omega_n s+\omega_n^2}$ ✓

$Output_s = \frac{A\omega{\omega_n}^2}{(s^2+\omega^2)(s^2+4\zeta\omega_n s+{\omega_n}^2)}$ ✓ (3)

6.2 $f(x) = 2\frac{dx}{dt} - 7x$

$f(x) = 2\,sx - 7x$ ✓

$f(x) = X(s)(2s-7)$ ✓ (2)

6.3 $F(s) = \frac{100}{s(s+4)(s+5)}$

$F(t) = \frac{100}{4\times5}\left[1+\frac{4e^{-5t}-5e^{-4t}}{5-4}\right]$ ✓✓

$F(t) = 5\,[1+4e^{-5t}-5e^{-4t}]$ ✓ (3)

[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
- Light-dependent resistor
- Light-dependent diode
- Light-dependent transistor or thyristor (Any 2 × 1) (2)

7.3
- The d.c. output voltage must be proportional to the r.m.s. value of the a.c. signal.
- The polarity of the d.c. output must be phase-sensitive. (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
- The system must be designed to operate safely.
- It must be efficient.
- It must be functional. (3)

8.2 A – Pump
B – Reservoir/Tank
C – Input
D – Differential lever
E – Output
F – Actuator/Cylinder
G – Servo-valve (7)
[10]

QUESTION 9

9.1
- It tends to overshoot, producing oscillations.
- It produces instability. (2)

9.2
- 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.
- Operating costs are cheaper.
- It is clean.
- It is easily available. (Any 5 × 1) (5)

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

9.4 Hunting – It is an increase in the gain of a system and causes the response to oscillate. (1)
[10]

QUESTION 10

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

10.2 Analog meter – The display uses a pointer needle on a scale.
Oscilloscope – The display is in the form of a trace. (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 will respond to various frequencies. (3)

10.4
- It is used as a time base in oscilloscopes.
- It is used in radar indicators. (2)

[10]

TOTAL: 100

DIAGRAM SHEET 1

QUESTION 4.1