higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

CONTROL SYSTEMS N6

8 AUGUST 2018

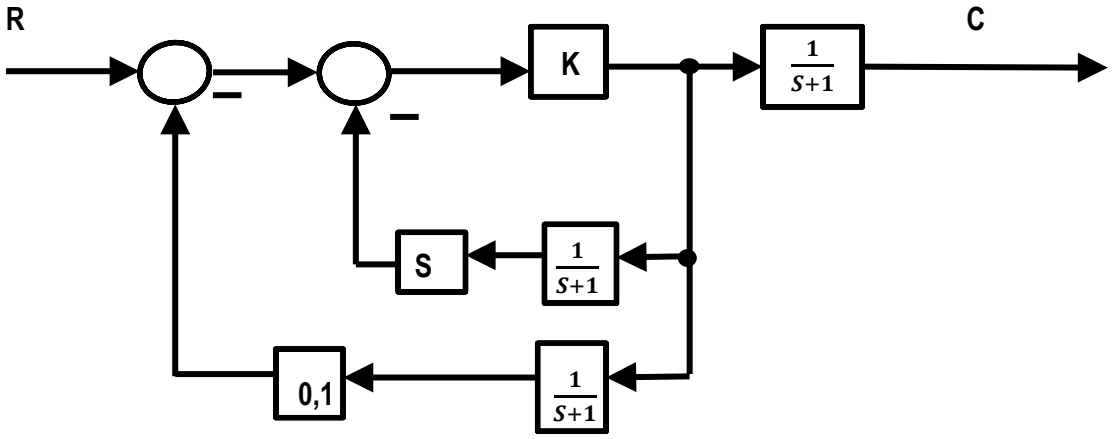
This marking guideline consists of 9 pages.

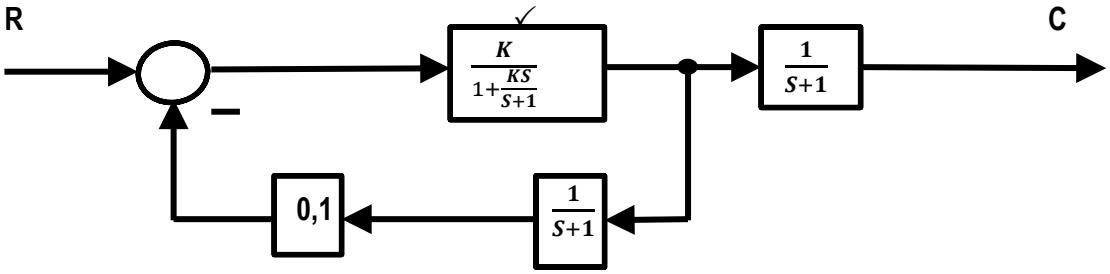
QUESTION 1

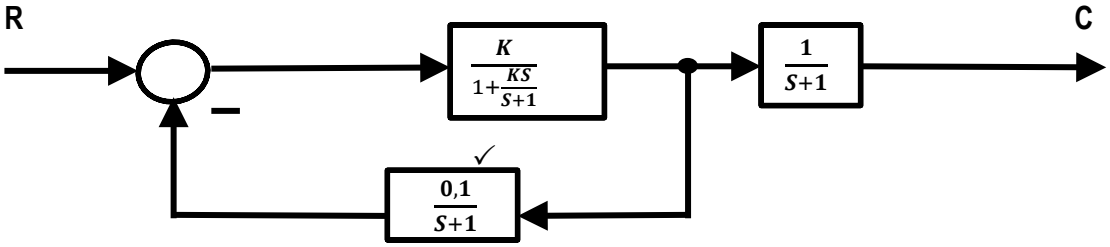
1.1 True
1.2 False
1.3 False
1.4 True
1.5 True
1.6 False
1.7 True
1.8 False
1.9 False
1.10 True

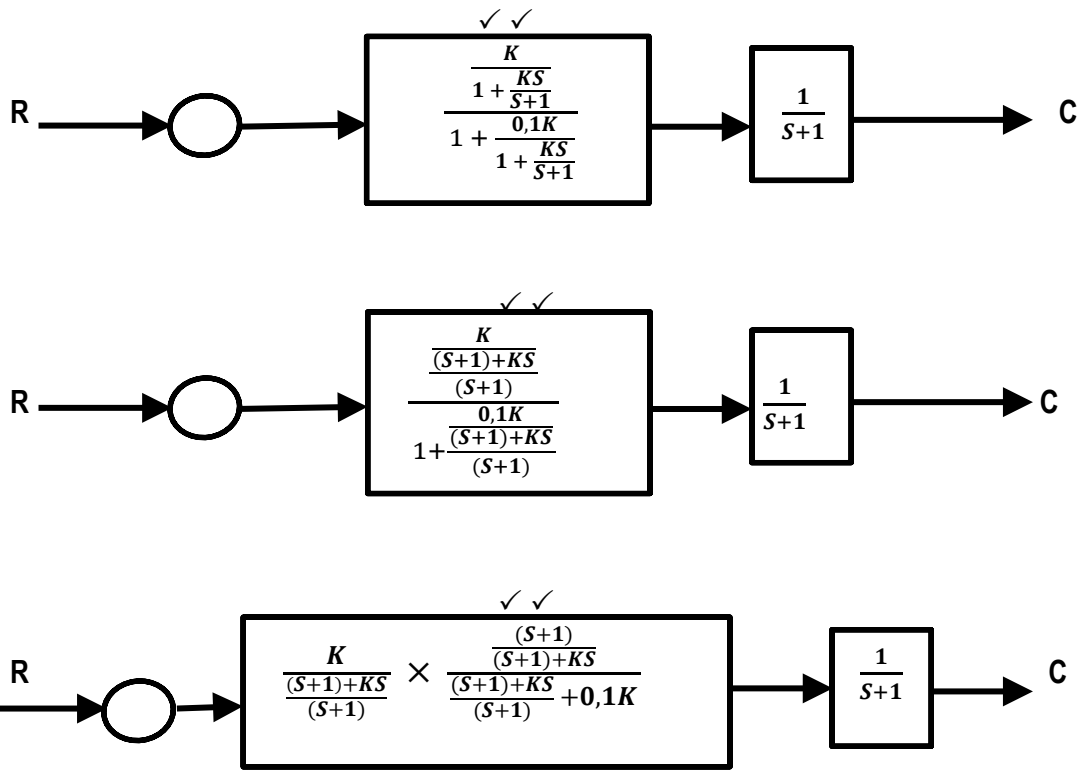
(10 × 1) **[10]**

QUESTION 2









$$\frac{C}{R} = \frac{K}{\frac{(S+1)+KS}{(S+1)}+0,1K} \times \frac{1}{(S+1)} \quad ✓$$

$$\frac{C}{R} = \frac{K}{S+1+KS+0,1K} \quad ✓ \qquad \textbf{[10]}$$

QUESTION 3

3.1	3.1.1	20,5 dB	(1)
	3.1.2	66 rad/s	(1)
	3.1.3	75 rad/s	(1)
	3.1.4	21,5 dB/decade or 10 dB/octave	(1)
	3.1.5	1,25 dB (below unity therefore positive)	(1)
	3.1.6	180° – 178,5° = 1,5°	(1)
	3.1.7	The system is stable because the gain response is below unity when the phase is -180° and the phase is shy of -180º when the gain is in unity.	(2)

3.2 A system is considered unstable when the gain and phase margins have negative values because they exceed the unity and 180° respectively. (2)
[10]

QUESTION 4

4.1	4.1.1	6,3 dB	(1)
	4.1.2	21°	(1)
	4.1.3	5,2 rad/sec	(1)
	4.1.4	7,4 rad/sec	(1)
	4.1.5	5,3 rad/sec	(1)
	4.1.6	5,4 rad/sec	(1)
	4.1.7	10 dB and -103°	(2)
	4.1.8	8,3 rad/sec	(1)
4.2		Stable	(1)

[10]

QUESTION 5

5.1 The denominator = $S^2 + 4S + 20A$

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

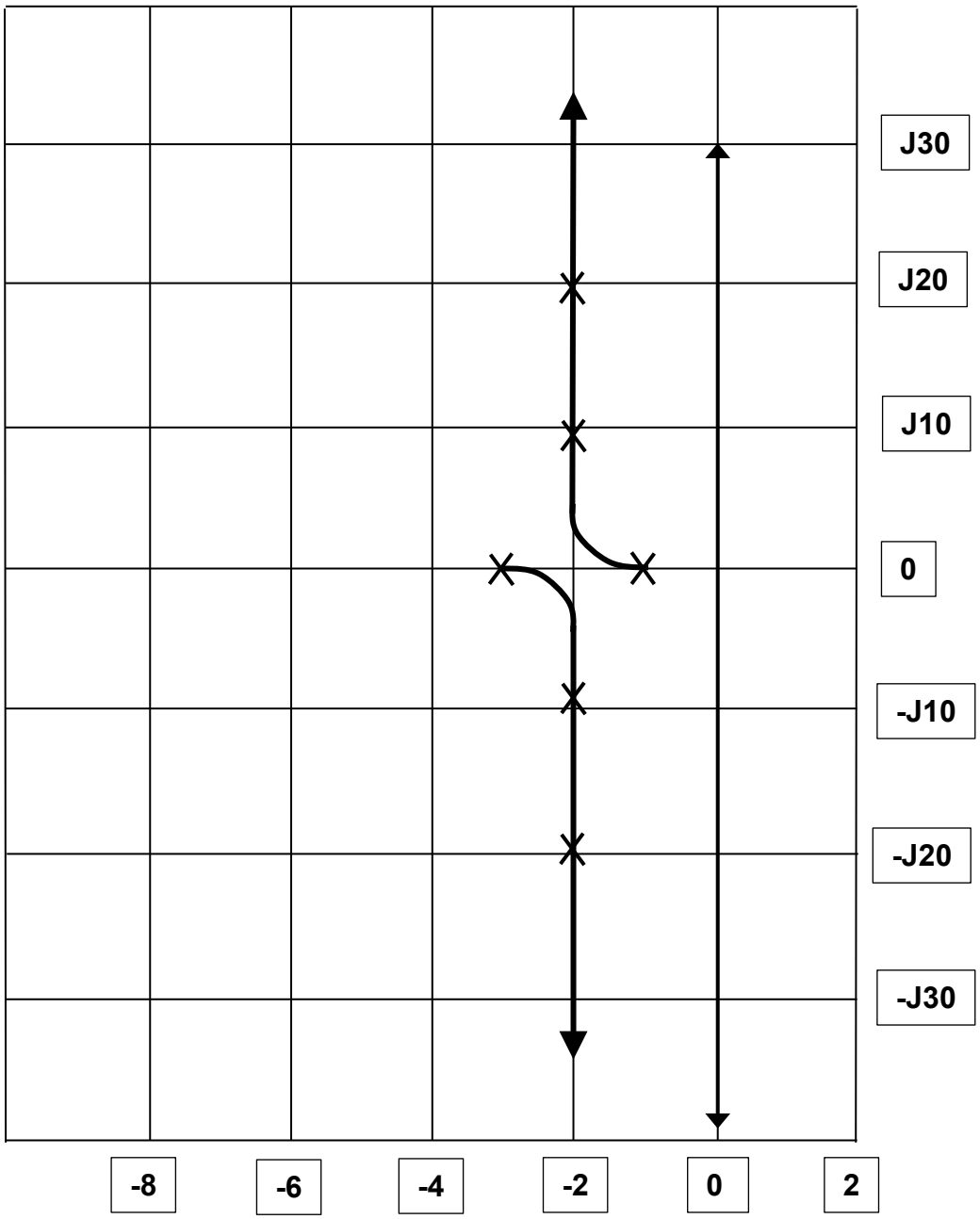
$$= \frac{-(4) \pm \sqrt{2^2 - 4(1)(20\text{A})}}{2(1)}$$

$$= -2 \pm \frac{\sqrt{4 - 80\text{A}}}{2} \quad \checkmark$$

		✓	✓	✓	✓
A	0	4	20	∞
S_1	-1	-2+j8,889	-2+j19,975	-2+j∞
S_2	-3	-2-j8,889	-2-j19,975	-2-j∞

(5)

5.2



(5)
[10]

QUESTION 6

$$\frac{\theta(s)}{Ta(s)} = \frac{1}{0,15s^2+0,5s+1} = \frac{A\omega_n{}^2}{s^2 + 2\zeta\omega_n s + \omega_n{}^2}$$

6.1 $\omega_n{}^2 = 1$
$\omega_n = \sqrt{1}$✓
$\omega_n = 1$ rad/s✓ (2)

6.2 $2\zeta\omega_n = 0,5$

$\zeta = \frac{0,5}{2\times1}$✓

$\zeta = 0,25$✓ (2)

6.3 $\omega_d = \omega_n\sqrt{1-\zeta^2}$
$\omega_d = 1\sqrt{1-0,25^2}$ ✓
$\omega_d = 0,968$ rad/s✓ (2)

6.4 $\omega_b = \omega_n\sqrt{1-\zeta^2+\sqrt{2-4\zeta^2+4\zeta^4}}$

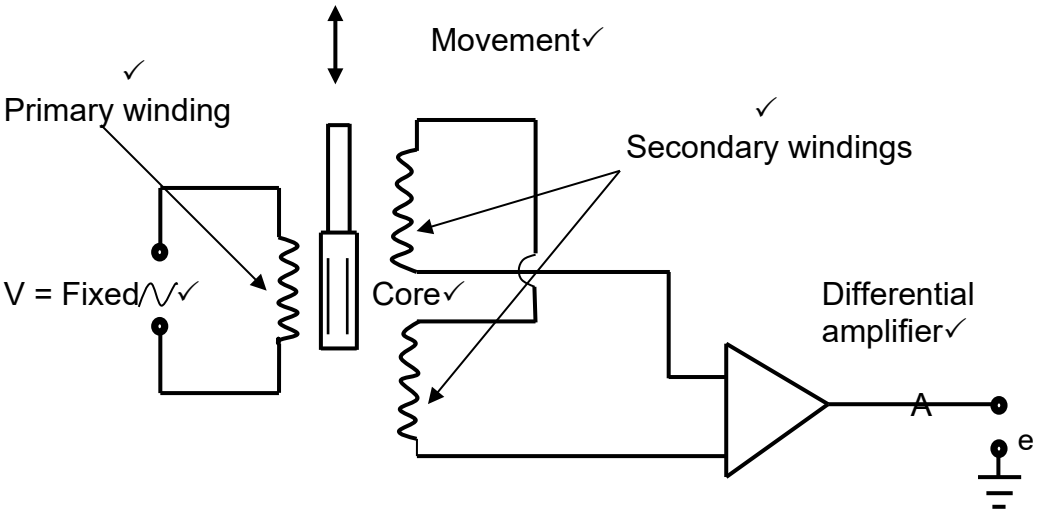
$\omega_b = 1\sqrt{1-0,25^2+\sqrt{2-(4\times0,25^2)+(4\times0,25^4)}}$ ✓✓

$\omega_b = 1,5$ rad/s✓ (3)

6.5 $\propto = \zeta\omega_n$
$\propto = 0,25 \times 1$
$\propto = 0,25$✓ (1)
[10]

QUESTION 7

7.1



(6)

7.2
- It has a primary winding with a fixed AC voltage and two secondary windings opposing each other. A movable magnetic core couples the windings.
- When the core is entered, the voltage of both the secondary windings is the same due to the flux path being identical and the output voltage is zero.
- As the core moves up or down the magnetic coupling causes an increase in induced voltage in either the top or bottom secondary winding.
- The output voltage is proportional to the displacement with a phase relationship depending on the direction of displacement. (4)

[10]

QUESTION 8

8.1
- Radial-action piston pump
- Axial piston-type pump (2)

8.2 8.2.1 Vane-type pump (1)

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

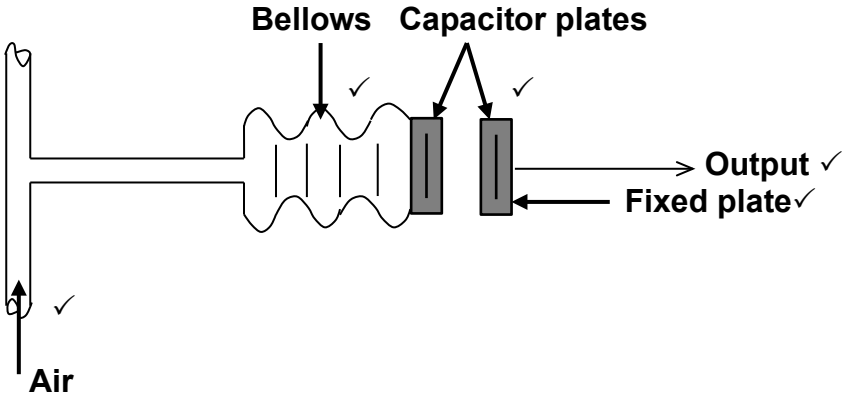
8.2.3
- As the rotor turns, a vacuum is created at the inlet side of the pump and fluid is sucked in.
- The sliding vanes which slide in the rotor move outwards due to a centrifugal force.
- The centrifugal force and pressure keeps the vanes in contact with the casing as the vanes move the fluid along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

[10]

QUESTION 9

9.1 It cannot be used alone because it will not respond to a steady-state error. (2)

9.2



(5)

9.3
- 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.
- Steady state is a condition when the input signal is a constant amplitude cycle such as a sine wave and the output signal has also become a constant amplitude cycle. (Any 1 × 3) (3)

[10]

QUESTION 10

10.1
- Analog voltmeters
- Digital voltmeters (2)

10.2 10.2.1 Pulse repetition frequency is the number of pulses produced per second.

10.2.2 Mark-to-space ratio is the ratio of the width of the pulse to the time between pulses.

(2 × 2) (4)

10.3
- Cathode-ray tube
- Time-base generator
- Amplifiers
- Attenuator
- Power supplies (Any 4 × 1) (4)

[10]

TOTAL: 100