UNIVERSITY EXAMINATIONS

UNIVERSITEITSEKSAMENS

UNISA university of south africa

CSY3601

January/February 2016

CONTROL SYSTEMS III (THEORY)

Duration 3 Hours

100 Marks

EXAMINERS

FIRST	PROF G QI
SECOND	PROF Z WANG
EXTERNAL	DR AA YUSUFF

Programmable pocket calculator is permissible

Partial/limited open book examination. Specified material as indicated on examination paper, permissible

This examination question paper consists of 6 pages including this "cover" page,

Partial Open book exam Ogata, K Modern Control Engineering

Answer all the questions

Please note: **IF YOU ARE OF THE OPINION THAT INSUFFICIENT INFORMATION IS SUPPLIED FOR YOU TO ANSWER A PARTICULAR QUESTION, MAKE A REALISTIC ASSUMPTION, MOTIVATE IT AND THEN ANSWER THE QUESTION.**

QUESTION 1 MULTIPLE CHOICE QUESTIONS

1 1 In Bode diagrams, which of the following portion represents the high frequency noise resistant ability?

A low frequency part B median frequency part

C high frequency part D none

1 2 For the first and the second order systems, all coefficients of the system characteristic equation are all positive is the ( ) condition of system stability

A sufficient condition B necessary condition

C sufficient and necessary condition D none

1 3 The open loop transfer function of a system is $G(s)H(s)=\frac{K}{s^3(s+4)}$, then the root locus on the real axis is

A $[-4,\infty)$ B $[-4,0]$

C $(-\infty,-4]$ D $[0,\infty)$

1 4 The maximum overshoot σ_p of a system represents which of the following performance?

A. Relative stability B. Absolute stability

C. Responding speed D Steady state performance

1.5 If a second order system has damping ratio $\zeta > 1$, then the system characteristic roots are

A two unequal negative real

B two equal negative real

C two equal positive real D two unequal positive real

1.6 The open loop transfer function of a unit negative feedback system is Go(s)= $\frac{9}{s(s+6)}$ The damping ration is

A $\frac{1}{2}$ B. 1 C 2 D 4

1.7 The step function with magnitude x_0 is

A $r(t)=1(t)$ B $r(t)=x_0$ C $r(t)=x_0\,\delta(t)$ D $r(t)=x_0 \cdot 1(t)$

[14]

QUESTION 2 CIRCUIT ANALYSIS, STEADY STATE ERROR

Figure Q2 illustrates an RLC circuit The capacitor has capacitance C, the inductor has inductance L, and the resistor resistance R The input is the applied voltage $v_i(t)$ and the output is the voltage across the capacitor $v_o(t)$

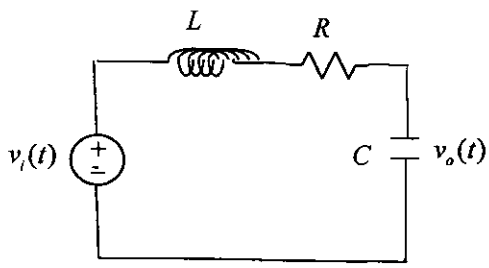

Figure Q2

2 1 Determine the transfer function relating v_o to v_i (5)

2 2 Let $v_i(t)$ be a unit step applied at $t = 0$ Use the final value theorem to find the steady-state value of $v_o(t)$ (5)

2 3 Set $L = 0\ 5\,\text{H}$ and $C = 4\times10^{-6}\ \text{F}$ Derive the value of R so that the response is damping ratio is $\varsigma = 0\ 707$ (10)

[20]

QUESTION 3 STEADY STATE ERRORS

A unity feedback system is shown in Figure Q3

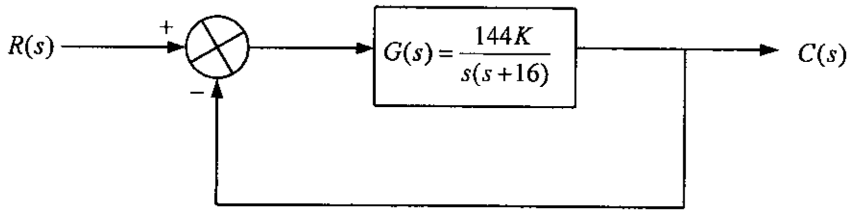

Figure Q3

3 1 For the transfer function $G(s)$, determine the type of system (4)

3 2 Find the error constants and steady-state errors for the basic types of inputs

3 2 1 2 step input, i e $R(s) = \frac{2}{s}$, (3)

3 2 2 Unit ramp input $R(s) = \frac{1}{s^2}$ (3)

[10]

QUESTION 4. STABILITY

The closed-loop system has the following characteristic equation Using the Routh Criterion determine the number of roots of each equation that are in the right-half-plane and stability

$$s^3 + 25s^2 + 10s + 450 = 0$$

[6]

QUESTION 5 ROOT LOCUS

The unity negative feedback system has an open loop transfer function $G(s)$ given by

$$G(s)=\frac{K(s+10)(s+5)}{(s-1)(s-5)}$$

5 1 Find the breakaway and break-in point manually (8)

5 2 Find the closed-loop transfer function and characteristic equation manually in terms of K Using Ruth-Hurwitz criterion find the value of K for which the closed-loop is marginally stable, i e the root-locus cross the imaginary axis manually Find the cross frequency manually (12)

5 3 Use information obtained in Question 3 1 and 3 2 to sketch the locus of the closed-loop system and mark the position of breakaway, break-in points and imaginary axis crossing point (5)

[25]

QUESTION 6 BODE DIAGRAMS

Sketch straight line approximations for the magnitude and phase Bode plots for a system with an open-loop transfer function $G(s)$ given by

$$G(s)=\frac{10(s+1)}{(s+5)(s+50)}$$

6 1 Give the frequency response form and magnitude response form $G(j\omega)$ according to the open-loop transfer function, and determine the magnitude in dB (6)

6 2 Describe the approximate properties of Bode plots at low frequency and high frequency (10)

6 3 Sketch the Bode plots using the information obtained in Question 4 1 and 4 2 (9)

[25]

[TOTAL: 100]