Al-Mustansiriyah University **College of Engineering** **Computer Eng. Dept.** **Undergraduate studies** **Exam : *Final* ( )**		**Subject: Control Examination** **Time: 3 Hours (180 min)** **Class:3rd** **Date: / / 2018**
	2017 – 2018	**Max.Mark: ١٠٠ mark**

NOTE: ANSWER <u>FOUR</u> QUESTIONS

<u>Q1</u>: the O.L.T.F of a closed loop system is $G(s)H(s)=\dfrac{e^{-as}(s+b)}{s^2+0.5s-1}$, **(25 Marks)**

<u>A)</u> Draw the state space diagram for the O.L.T.F.

<u>B)</u> the Nyquist plot for this system is shown in Fig.(1). See this figure then determine:

1. the stability of the C.L.T.F system. **2.** the value of the time delay *a* and the constant *b*, if you know that $\omega=$ for M=1 and P.M =

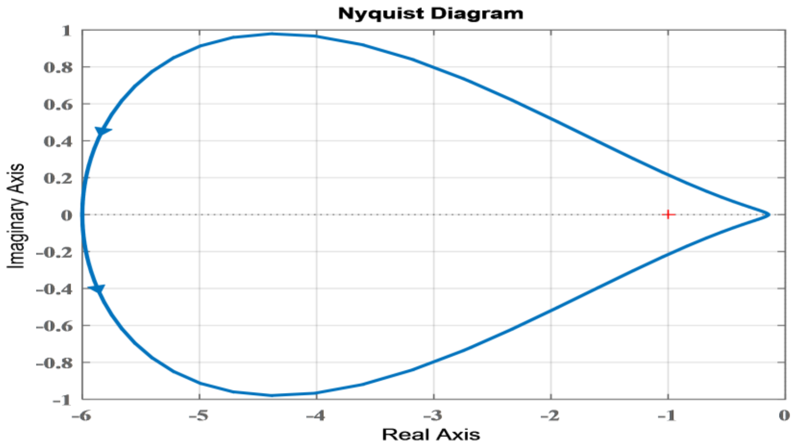


Fig.(1): Nyquist plot.

<u>Q2</u>: consider a second order unity feedback with plant *G*(*s*) and natural frequency=5 rad/sec., if unity impulse input is used to test this closed loop system for two case (critical stable response and critical damped response), then determine:

<u>i)</u> the G(*s*) equation for the both cases.
<u>ii)</u> the closed loop $y(t)$ equation for the both cases.
<u>iii)</u> depending on point **<u>ii)</u>** determine the values of ($y(t=t_s)$, $e_{s.s}$, time constant T, and σ) for critical damped response case.

<u>Q3</u>: **<u>A)</u>** consider the unity f/b system with O.L.T.F: **(15 Marks)**

$$G(s)=\frac{K(s^2-2s+4)}{(s^2+2s+4)}$$

sketch the complete root locus for this system and determine the range of *K* for stability.

<u>B)</u> If a series PID controller is given by $G_c(s)=3(s+4)$, then answer **<u>two</u>** from: **(10 Marks)**

i) If the controller parameters are determined by (Z-N) 1st tuning method then determine the approximate $G_r(s)$ equation.

ii) If the controller parameters are determined by (Z-N) 2nd tuning method then determine k_{cr} and the frequency ω.

iii) the controller parameters are determined by (P-Z) cancelation tuning method then determine the plant $G(s)$ equation.

<u>Q4</u>: Consider a unity feedback system with open loop D.E given by: **(25 Marks)**

$$\dddot{y}(t)+2\ddot{y}(t)+5\dot{y}(t)=k(6\dot{u}(t)+6u(t))$$

Then select the correct answer for **<u>five</u>** from the following points:

1. the O.L.T.F is: **a-** (stable 2nd order type 2) **b-** (unstable 2nd order type 2) **c-** (stable 4th order type 2 stable) **d-** (unstable 4th order type 2)

2. if the input is unite sine and (k=1, t=2 sec., ω=1 rad/sec.) then the value of $y_{s.s}(t)$ is:
a- (-0.6625) **b-** (1.8974) **c-** (2.334) **d-** (-4.1127)

3. according to Routh stability approach the k_{cr} and the frequency ω at sustained oscillation are:
a- (k_{cr}=2.34, ω=2.15) **b-** (k_{cr}=3.4, ω=4.2) **c-** (k_{cr}=6.01, ω=2.14) **d-** (k_{cr}=1.33, ω=1.41)

4. the value of k for $E_{s.s}$=0.2 and input $r(t)=(4t+2t^2)/2$ is: **a-** (3.861) **b-**(8.334) **c-** (4.645) **d-** (5.861)

5. the suitable controller for this system is: **a-** (PID) **b-** (PD) **c-** (PI) **d-** (P only)

6. the suitable tuning method for controller parameters is:
a- (robust method) **b-** (D-S method) **c-** (P-Z method) **d-** (C-C method)

<u>Q5</u>: Consider a unity feedback system with $G(s)=\dfrac{K(s^2+0.8s+0.4)}{s(1-xs)^2}$ and data given by the table(1), try to complete this table, determine the value of $\omega_{s.p}$, x, ω_x and sketch the bode plot on Fig.(2) then determine: **(25 Marks)**

<u>i)</u> the stability of the closed loop system.

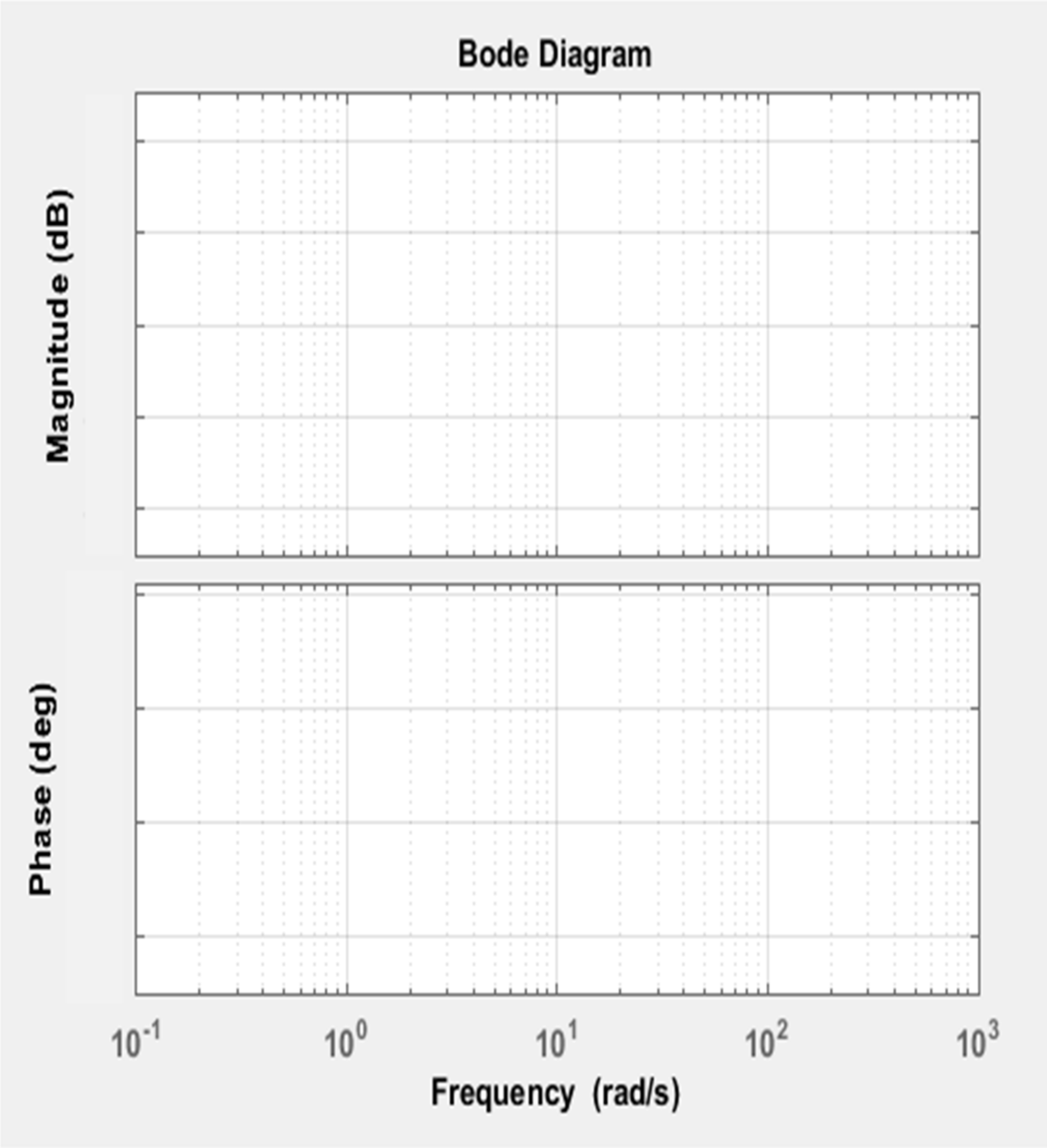
<u>ii)</u> the system gain k for gain cross-over frequency to be 0.4 rad/sec.

<u>iii)</u> the system gain k for maximum positive phase margin.

Table(1): bode data.

ω	$\omega_{s.p}$	0.635	ω_x	100	1000
Mag.	20	11.2	21.9	7.84	-12
Φ	-437	-335	-185	-102	-91.2

Fig.(2):Bode plot.



Examiner: Ekhlas Hameed Karam

Head of Department: Assist.Prof. Nasir Ahmad