Benha University	**Department:Electrical Program**
Benha Faculty of Engineering	**Time:3 hours**
Date:16/6/2019	**Subject: Control Engineering**
Semester: 2	**Code:E1236**
Examiner:Dr.Shawky Arafah	**No. of Pages: 4**
Total Points:75	

Question ① (*10 marks*) **الاجابة بالجاف الازرق والرسم والتسويد بالرصاص وتسلم اوراق الاسئلة**

A physical system consists of series **RLC** circuit as shown in Fig.1. The input is $v_i(t)$ and the output is the capacitor voltage $v_o(t)$. The system parameters are L=1 Henry, C=0.01 Farad, and R=10 Ohm. i-Find a **mathematical model** and **Laplace model**? (2)

ii- Draw a unity feedback block diagram and find $E_o(S)/E_i(S)$? (4)

iii-Find the state space model using two state variables? (4)

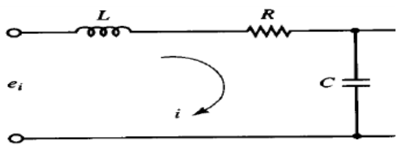

Fig.1

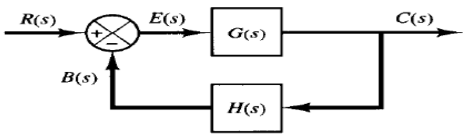

Fig.2

Question ② (***15 marks***)

Consider a system shown in Fig. 2 has $H(s) = 1, \quad G(s) = \frac{9}{S(S+3)}$

i-Find the steady state static **error coefficients**? (3)

ii- Find and draw the **unit step response** as K=9? (7)

iii- Find the **frequency response** and $\mathbf{M_r}$ **and** $\boldsymbol{\omega_r}$ as K=9 and r(t)=10sin ωt ? (5)

Question ③ (10 marks)

Consider a unity feedback control system has

$$G(s) = \frac{k}{(S+3)(S+2+j3)(S+2-j3)} = \frac{k}{S^3+7S^2+25S+39}$$

i- Sketch **complete root locus** for positive values of **K?**

ii-Find **K** that makes the complex closed loop poles have a damping ratio =**0.3** and **find the closed loop poles** using **the plot**? iii-Write short MATLAB program to solve i and ii?

Question ④ (***20 marks***)

Consider a control system shown in Fig.2 has an open loop TF=$G(s)H(s) = \frac{100}{S^3+9S^2+28S+40}$

a-Prove that the gain margin=**6.54 db at 5.3 rad/sec**.and the phase margin= **31.7 degrees at 3.73 rad/sec**.? (4)

b-Sketch the **polar plot and Bode plot** ? (12)

c-Write short MATLAB program to solve a and b? (4)

Question ⑤ (***20 marks***) التسويد بالرصاص وتسلم اوراق الاسئلة *Best Wishes for all, Examiners*

Question 5- Choose the correct answer Class A (20 marks)

1-BIBO control system is (a) stable-control system (b) unstable-control system (c) critical-stable control system

2-a control system has zero-impulse response is (a) stable (b) unstable- (c) critical-stable control system

3- If the output of the physical system is hard to measured or economically not feasible

(a) it is convenient to use open loop control system (b) it is convenient to use closed loop control system

4-a control system has all poles in the left half of s-plane (L.H.S) and only one zero on the jω-axis is

(a) critical-stable control system (b) unstable-control system (c) stable control system

5-a control system has all poles in the left half of s-plane (L.H.S) and one zero in the R.H.S plane is

(a) unstable-control system (b)stable-control system (c) critical-stable control system

6-a control system has two-poles in the right half of s-plane (R.H.S) and ten-poles in the L.H.S plane is

(a) unstable-control system (b) stable-control system (c) critical-stable control system

7-a second-order control system has η=one is (a) stable (b) unstable- (c) critical-stable control system

8-a step-response of a second-order control system which has η=half is

(a) under-damped response (b) over-damped response (c) critical-damped response

9-a stable-second-order control system has an under-damped frequency= ω_d

(a) $\omega_d < \omega_n$ (b) $\omega_n < \omega_d$ (c) $\omega_r > \omega_d$ (d) none

10- a step-response of second-order control system has $\eta = 0.5$ must have $t_r > t_{settling}$

(a) no (b) yes

11- roots of the denominator of the open loop TF are the

(a) Open loop -zeros (b) Open loop -poles (c) Closed loop- zeros (d) Closed loop- poles

12- roots of the nominator of the open loop TF are the

(a) Open loop -poles (b) Open loop-zeros (c) Closed loop- zeros (d) Closed loop- poles

13- roots of the denominator of the control ratio are the

(a) Open loop -zeros (b) Closed loop -poles (c) Closed loop- zeros (d) Open loop- poles

14-a control system has positive-gain margin and positive phase margin is

(a) critical-stable-control system (b) stable-control system (c) unstable control system

15-a control system has zero-gain margin and positive phase margin is

(a) stable-control system (b critical-stable control system (c) unstable control system

Class A

16-a steady state static error of a control system depends on

(a) control-ratio (b) error ratio and input (c) error ratio and input and derivatives of the input

17-a steady state dynamic error of a control system depends on

(a) control-ratio (b) error ratio and input and derivatives of the input (c) error ratio and input

18-a steady state ramp static error of a control system equal to

(a) $\frac{2*a_3}{K_a}$ **(b)** $\frac{a_2}{K_v}$ **(c)** $\frac{a_1}{1+K_p}$ **(d)none**

19-the gain cross-over frequency is equal to

(a) ω_d **(b)** ω_g **(c)** ω_n **(d)** ω_p **(e)** ω_r

20-the root locus for a stable linear time-invariant control system is symmetrical about σ-axis in S-plane

(a)no (b) yes (c) none

21- disturbances may cause errors when using

(a) open and closed loop control system (b) closed loop control system (C) open loop control system

22- recalibration is not necessary when using

(a) open loop and closed control system (b) open loop control system (C) closed loop control system

23-changes in calibration cause errors when using

(a) open loop and closed control system (b) closed loop control system (C) open loop control system

24- a control system has all poles and zeros in the left half of s-plane (L.H.S) is

(a) critical-stable control system (b) unstable-control system (c) stable control system

25-the control system has two inputs and one output is

(a)- Single input single output SISO (b)-Single input multi output SIMO (c)- Multi input single output MISO 26-disturbances do not cause errors when using

(a) open loop control system (b) open and closed loop control system (C) closed control system

27- recalibration is necessary when using

(a) open loop and closed control system (b) closed loop control system (C) open control system

28- a control system has all poles in the left half of s-plane (L.H.S) and one zero in the R.H.S is

(a) critical-stable control system (b) stable-control system (c) unstable control system

Class A 29- If the output of the physical system is hard to measured or economically not feasible, it is convenient to use

(a) unstable control system (b) closed loop control system (C) open loop control system

30-the control system has two inputs and two outputs is

(a)- Single input single output SISO (b)-Single input multi output SIMO (c)- Multi input Multi- output MIMO

31-a step-response of a unstable-second-order control system is

(a) under-damped response (b) over-damped response (c) critical-damped response (d) none

32-the root locus for a stable linear time-invariant control system in S-plane starts at

(a) origin (b) zero (c) any point in S-plane (d) pole

33-the root locus for a linear time-invariant control system in S-plane ends at

(a) infinity (b) zero (c) any point in S-plane (d) zero or infinity

34-number of the root-locus for a linear time-invariant control system in S-plane equals to

(a) number of closed loop poles (b) number of open loop zeros (c) zero (d) number of open loop poles

35-number of asymptotes in root-locus of linear control system in S-plane equals to

(a) number of open loop (poles+zeros) (b) number of open loop zeros (c) number of open loop (poles-zeros)

36-in the root locus for linear control system break-points are determined using

(a) Routh-test (b) $\frac{d}{dS}[G(S)H(S)] = 0$ **(c)** $1 + G(S)H(S) = 0$ **(d)** $\frac{d}{dS}\left[\frac{1}{G(S)H(S)}\right] = 0$

37-in the root locus for linear control system points of intersection with jω-axis are determined using

(a) $\frac{d}{dS}\left[\frac{1}{G(S)H(S)}\right] = 0$ **(b)** $\frac{d}{dS}[G(S)H(S)] = 0$ **(c)** $G(S)H(S) = 0$ **(d) Routh-test**

38- the polar plot of the locus of the vector $G(j\omega)H(j\omega) = M\llcorner\Phi$ **on the Real-imaginary plane as ω changes from zero to infinity is the**

(a)Bode-plot (b) Nichols- plot (c) Margin- plot (d) Nyquist - plot

39- the plot of $G(j\omega)H(j\omega) = M\llcorner\Phi$ **as M in db on the vertical axis against Φ in degrees on the horizontal axis in the X-Y plane and ω changes from zero to infinity is the**

(a) Nyquist-plot (b) Bode - plot (c)Margin- plot (d) Nichols - plot

40- the plot of $G(j\omega)H(j\omega) = M\llcorner\Phi$ **consists of two parts on semi-log paper. The upper part is the plot of M magnitude in db against ω (log scale) and the lower part is the plot of the phase Φ in degrees against ω (log-scale) and ω changes from zero to infinity is the**

(a) Nyquist-plot (b) Nichols- plot (c) polar- plot (d) Bode - plot