Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
August, 2018

Level : B.E.
Year : III

Course : COEG 301
Semester: II

Exam Roll No. : Time: 30 mins. F. M. : 10

Registration No.: Date AUG 2 3 2018

SECTION "A"
[20 Q. × 0.5 = 10 marks]

Encircle the most appropriate answer to the following questions.

1. A plant in a control system represents .... components working together.
(a) physical (b) chemical (c) biological (d) economical

2. Spring constant in force-voltage analogy is analogous to .....
(a) capacitance (b) reciprocal of capacitance
(c) inductance (d) reciprocal of resistance

3. In a thermal system the thermal capacitance is given by ....
(a) $\frac{\Delta Q}{\Delta H}$ (b) $\frac{\Delta m}{\Delta p}$ (c) $\frac{\Delta \theta}{\Delta H}$ (d) $\frac{\Delta \theta}{H}$

4. For a gear in a rotational system N_1 is the gear teeth on the input side and N_2 is the gear teeth on the output side. If the gear ratio N_1:N_2 is 10:1, the speed of the input side is 10 m/s the seed of the output side is.........
(a) 1 m/s (b) 10 m/s (c) 100 m/s (d) 1000 m/s

5. The state space matrix for the transfer function $\frac{C(s)}{R(s)}$ of the system shown in Fig. 1 is ...
(a) $\begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix}$ (b) $\begin{bmatrix} 1 & 1 \\ 0 & -1 \end{bmatrix}$ (c)$[-1]$ (d) $[3]$

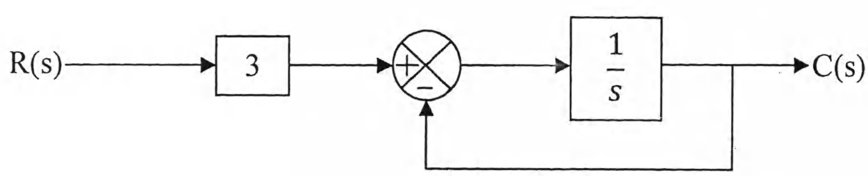

Fig. 1

6. Consider a system with the transfer function$(s) = \frac{s+6}{Ks^2+s+6}$. Its damping ratio will be 0.5 when the value of K is
(a) 2/6 (b) 3 (c) 1/6 (d) 6

7. Fig. 2 shows a unity feedback closed loop control system. The steady state error of the system to unit ramp input is .....
(a) 0 (b) 2 (c) 0.5 (d) ∞

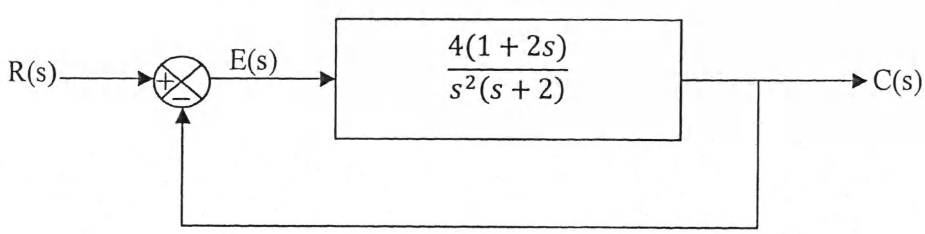

Fig. 2

8. A second-order system has the damping ratio ζ=0.5, undamped natural frequency ω_n=10 rad/s and the steady state value of the output to a unit step input 1.02. The transfer function of the system is .....

(a) $\frac{1.02}{s^2+5s+100}$ (b) $\frac{102}{s^2+10s+100}$ (c) $\frac{100}{s^2+10s+100}$ (d) $\frac{102}{s^2+5s+100}$

9. The number of roots with positive real parts for the system with characteristics equation $2s^3 + 4s^2 + 4s + 12 = 0$ is ....

(a) one (b) two (c) three (d) four

10. The open loop transfer function of a control system is, $G(s)H(s) = \frac{K(s+1)(s+5)}{s(s+2)(s+3)}$. For K > 0, the point on the real axis that does not belong to the root locus of the system is ...

(a) -0.5 (b) -2.5 (c) -3.5 (d) -5.5

11. A closed-loop system has the characteristic function $(s^2 - 4)(s + 1) + K(s - 1) = 0$. Its root locus plot against K is as shown in .....

(a) Fig. 3.a (b) Fig. 3.b (c) Fig. 3.c (d) Fig. 3.d

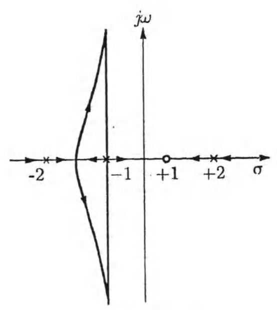

Fig. 3.a

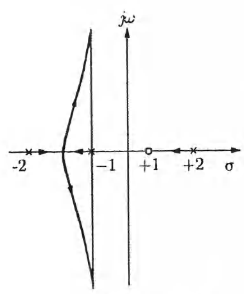

Fig. 3.b

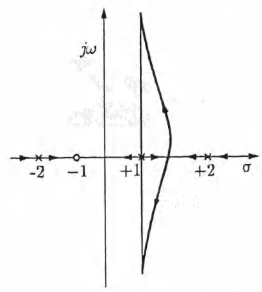

Fig. 3.c

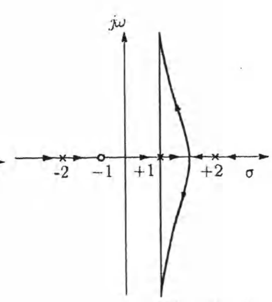

Fig. 3.d

12. A system has fourteen poles and two zeros. Its high frequency asymptote in its magnitude plot will have a slope of ......

(a) – 40 dB/decade (b) – 240 dB/decade (c) – 280 dB/decade (d) – 320 dB/decade

13. The open-loop transfer function of a feedback control system is $G(s)H(s) = \frac{1}{(s+1)^3}$. The gain margin of the system is ....

(a) 2 (b) 4 (c) 8 (d) 16

14. The transfer function C(s)/R(s) for the signal flow graph shown in Fig. 4 is ....

(a) $\frac{G_1G_2}{1+G_1H_1}$ (b) $\frac{G_1G_2}{1-G_1H_1}$ (c) $\frac{G_1+G_2}{1-G_1H_1}$ (d) $\frac{G_1+G_2}{1+G_2H_1}$

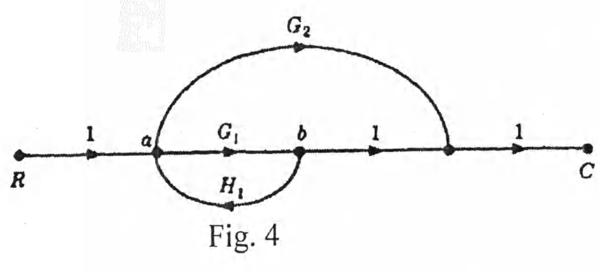

Fig. 4

15. The block diagram of a system is shown in Fig. 5. If the desired transfer function is $\frac{C(s)}{R(s)} = \frac{s}{s^2+s+2}$, then G(s) is ....

(a) 1 (b) s (c) $\frac{1}{s}$ (d) $\frac{-s}{s^3+s^2+s-2}$

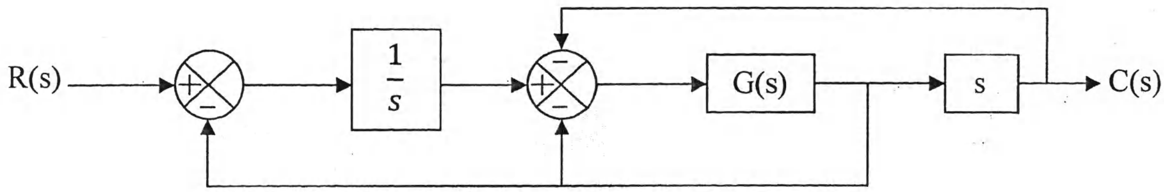

Fig. 5

16. For the asymptotic Bode magnitude plot shown in Fig. 6, the system transfer function will be ....

(a) $\frac{0.1s+1}{10s+1}$ (b) $\frac{100s+1}{0.1s+1}$ (c) $\frac{100s}{10s+1}$ (d) $\frac{10s+1}{0.1s+1}$

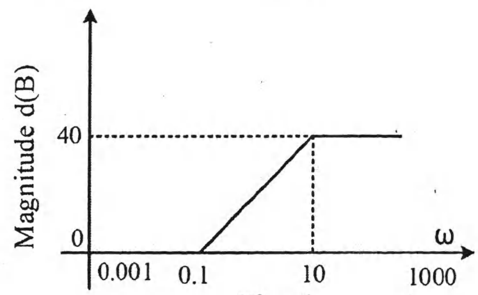

Fig. 6

17. The number of poles P_0 enclosed by the Nyquist plot of a system in Fig.7 and with $Z_0 = 0$ is ....

(a) 0 (b) 1 (c) 2 (d) 3

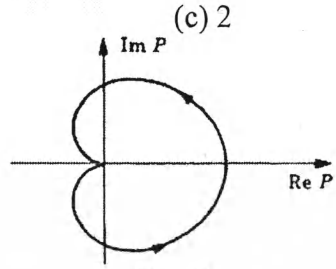

Fig. 7

18. Constant N-loci in the Nichols chart are ....

(a) Constant gain and constant phase shift loci of the closed-loop system.
(b) Plot of loop gain with the variation in frequency
(c) Circles of constant gain for the closed loop transfer function
(d) Circles of constant phase shift for the closed loop transfer function

19. The pole zero plot of open transfer function system shown in Fig. 8 and the steady state gain is 2, the transfer function G(s) will be given by ....

(a) $\frac{3(s+1)}{s^2+4s+5}$ (b) $\frac{5(s+1)}{s^2+4s+5}$ (c) $\frac{10(s+1)}{s^2+4s+5}$ (d) $\frac{10(s+1)}{(s+2)^2}$

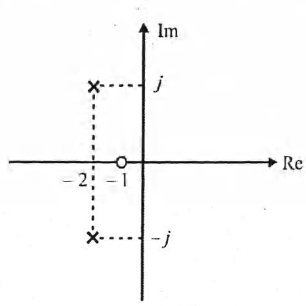

Fig. 8

20. A second-order system has the transfer function $\frac{C(s)}{R(s)} = \frac{4}{s^2+4s+4}$. With r(t) as the step input the response c(t) of the system is represented by ......

(a) Fig. 9 (i) (b) Fig. 9 (ii) (c) Fig. 9 (iii) (d) Fig. 9 (iv)

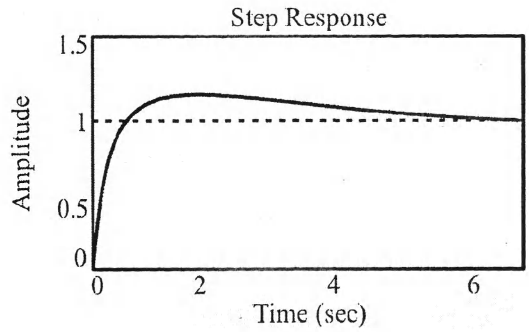

Fig. 9 (i)

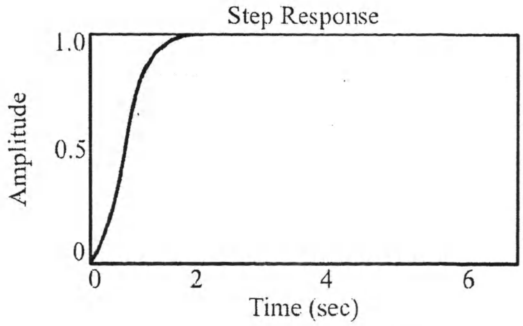

Fig. 9 (ii)

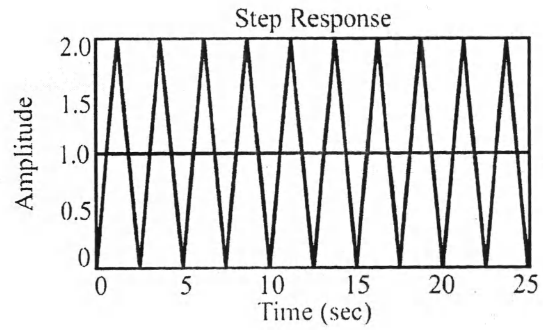

Fig. 9 (iii)

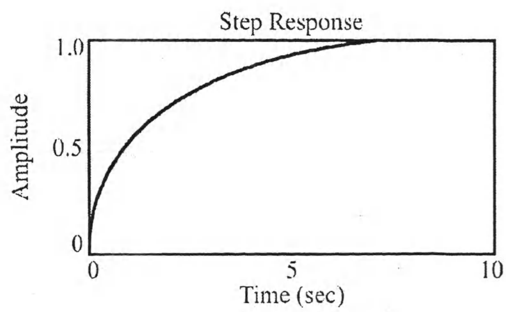

Fig. 9 (iv)

KATHMANDU UNIVERSITY
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Level : B.E.
Year : III
Time : 2 hrs. 30 mins.

Course : COEG 301
Semester : II
F. M. : 40

SECTION "B"
[5Q × 8 = 40 marks]

Attempt *ANY FIVE* questions. Assume necessary data if required.

1. Water mill (*pani ghatta*) as shown in Fig. 1 are still being used in remote hilly regions of Nepal. The water from the penstock strikes the turbine and the turbine rotates to provide a torque to rotate one of the stone of the grinder which is attached to the common shaft. The grains are put from the top into the gap between the two stones. The grains get grinded with the movement of one of the two stones of the grinder.

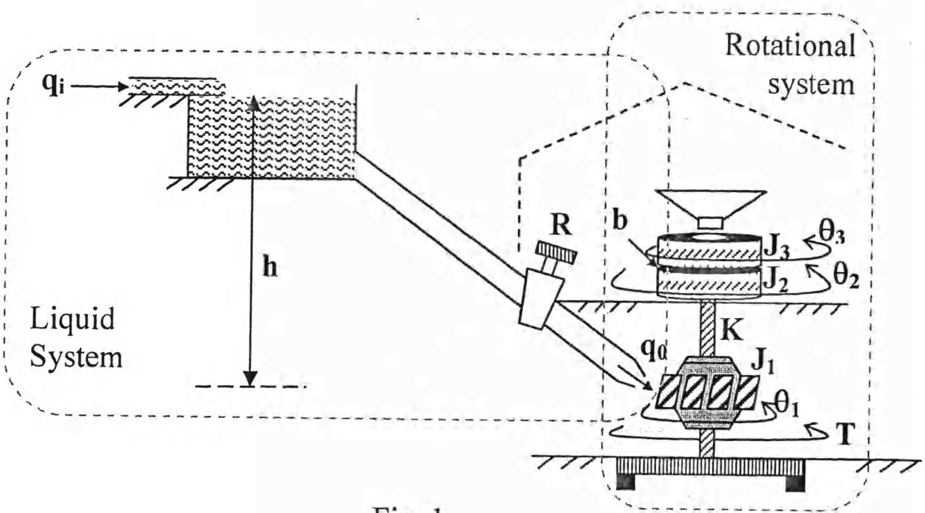

Fig. 1

The discharge of water inlet to the forbay tank is q_i, the area of the forebay tank is A, R is the resistance offered by the gate valve to the water flow and q_0 is the output discharge from the pipe to the turbine. The power delivered by water to the turbine is given by $P = 5 \times h \times q_0$. Also the power at the turbine shaft is related with torque as, $P = T\frac{d\theta_1}{dt}$. The rotational systems with its moment of inertias, shaft-spring torque, damping torque between two stones are as shown in Fig.1.

(a) Determine the transfer function relating the input q_i and output θ_2 of Fig.1. [5]

(b) Determine the state space model of the rotational system of Fig. 1. Consider θ_1, θ_2 and θ_3 as output variables and torque T as the input variable. [3]

2. (a) For the liquid system of Fig. 1 if $q_i = 10\ m^3/s$, steady state value of $q_0 = 5\ m^3/s$, maximum value of $q_0 = 8\ m^3/s$ at time t = 10 seconds determine the value of A and R of the system. Also draw the time response curve of q_0. [3]

(b) Sketch the Nyquist plot for the system in Fig. 2 and determine the gain margin, phase margin and stability of the system. [5]

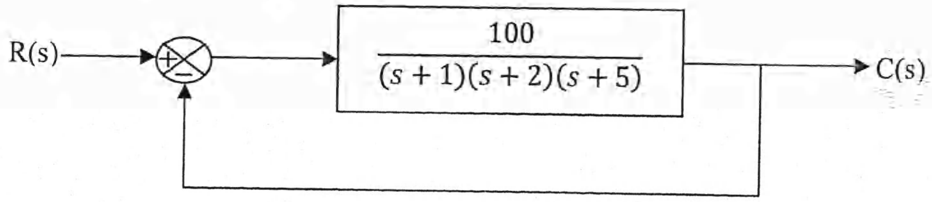

Fig. 2

3. Fig. 3 (i) shows a trolley bus whose motor power supply and motor-wheel interlink is as presented in Fig. 3 (iii). The armature controlled dc motor of the tram gets power from the power lines through the transformer and rectifier. Assume the conversion gain of rectifier to be 0.9 and the turn ratio of the transformer $N_1 : N_2 = 4:1$. Also for the dc motor $J_a = 5$ kg-m^2, $f_a = 2$ N-ms/rad, and for the shafts stiffness $K_1 = 1000$ N-ms/rad, $K_2 = 1200$ N-ms/rad and $K_3 = K_4 = 800$ N-ms/rad. The torques speed curve of the motor is as depicted in Fig. 3(ii).

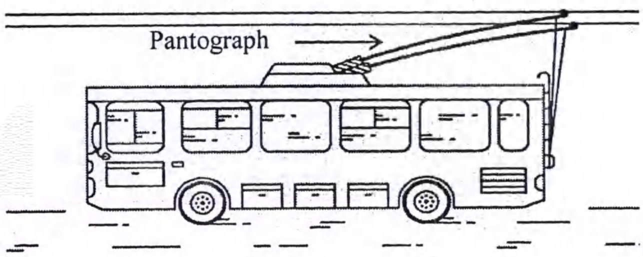

Fig. 3 (i)

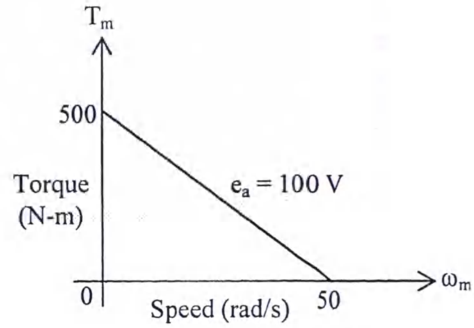

Fig. 3 (ii)

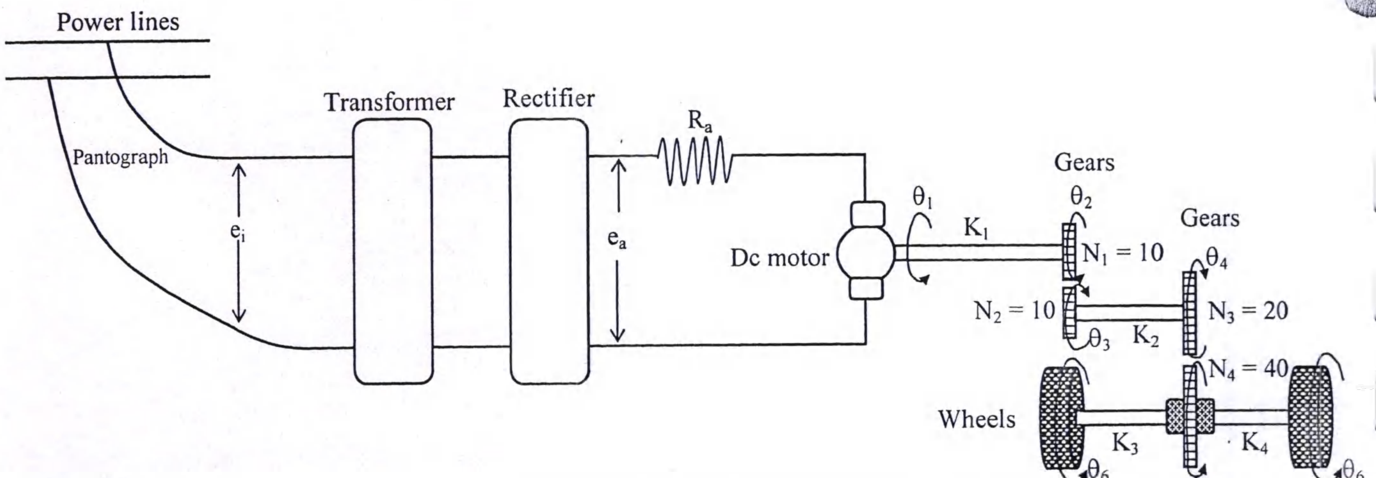

Fig. 3 (iii)

(a) Determine the transfer function relating the input e_i and output θ_6 of Fig. 3 (iii). [5]

(b) Using Routh-Hurwitz criterion to check the stability of the unity feedback system with the transfer function in (a). [3]

4. (a) The block diagram of a temperature control system is presented in Fig. 4. The input signal is a voltage and represents the desired temperature θ_r which is a unit step function. Determine the steady state error of the system with R = 0.02 and (i) $D(s) = 1$; (ii) $D(s) = \frac{0.1}{s}$; (iii) $D(s) = 1 + 0.3s$. Comment on the behavior of the systems with the three different types of controllers. [3]

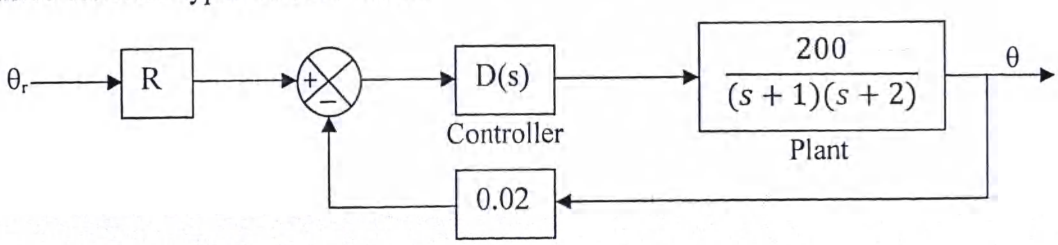

Fig. 4

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(b) For the system in Fig. 4 consider R =1 and controller $D(s) = \frac{1}{s}$, the transfer function of the plant $P(s) = \frac{K}{(s+1)(s+2)}$ and feedback element transfer function = 1. Sketch the root loci of the system and determine the range of K for stability. [5]

5. Consider a unity feedback system with feed forward transfer function

$$G(s) = \frac{K}{(2s+1)(s+1)(0.5s+1)}.$$

Design a lag compensator for the system such that phase margin is at least 25° and $K_p = 9$. Use Bode plot for the design and plot the responses on a semi-log graph paper. [8]

6. (a) Convert the block diagram of Fig. 5 in a signal flow graph and obtain the overall transfer function of the system using Mason's Gain formula. [5]

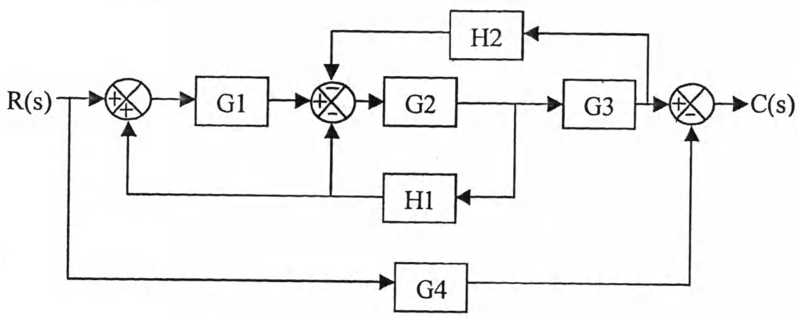
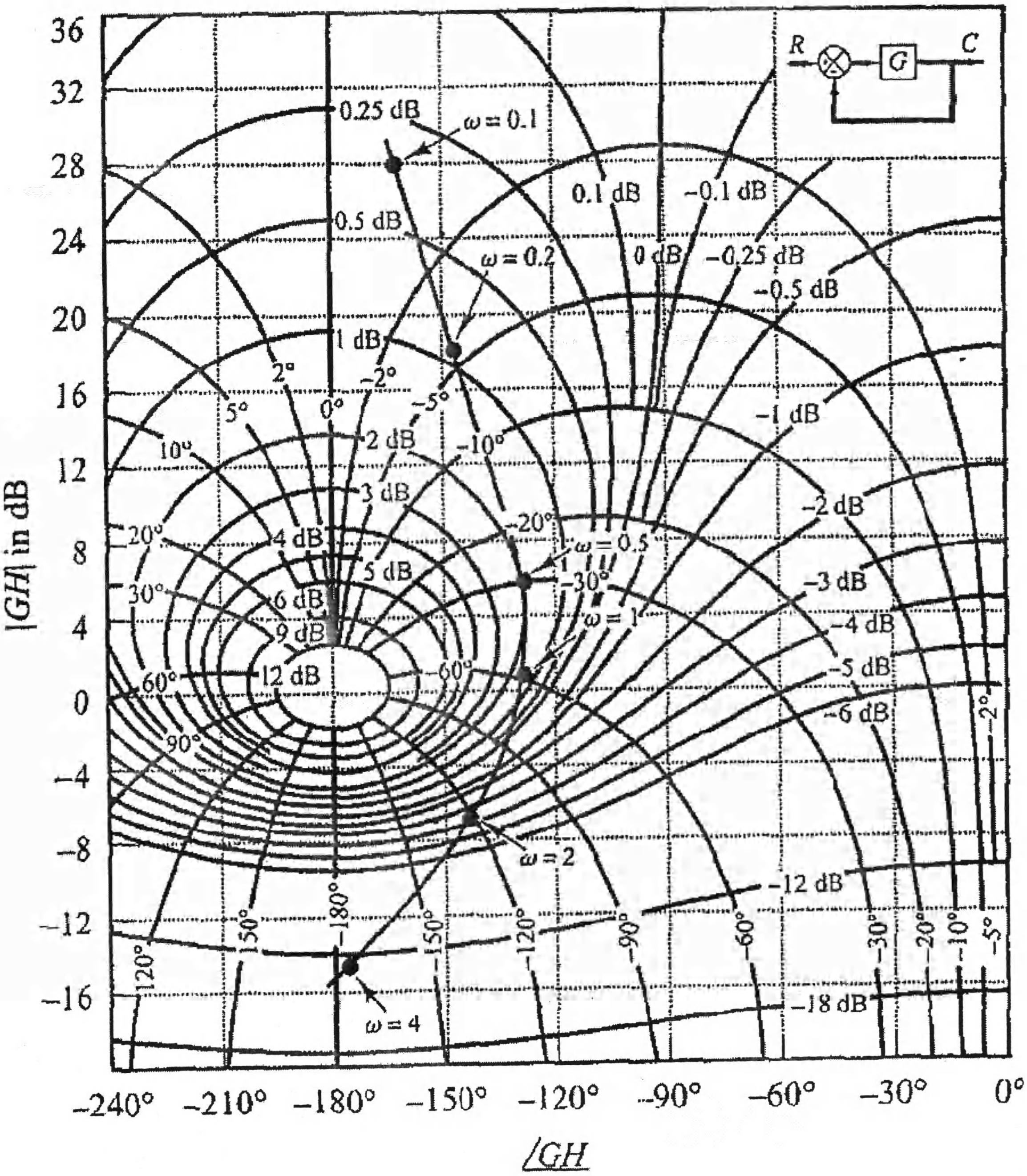


Fig. 5

(b) The Nichol's plot for a feedback system is shown in Fig. 6. Determine the resonant peak, resonant frequency, system bandwidth, phase margin and gain margin of the system.

[3]



|GH| in dB
/GH
R
G
C
0.25 dB
ω = 0.1
0.5 dB
ω = 0.2
1 dB
2 dB
3 dB
4 dB
5 dB
6 dB
9 dB
12 dB
0.1 dB
-0.1 dB
0 dB
-0.25 dB
-0.5 dB
-1 dB
-2 dB
-3 dB
-4 dB
-5 dB
-6 dB
-12 dB
-18 dB
ω = 0.5
ω = 1
ω = 2
ω = 4

Fig.6

101- Simple Log, 4 Scale Log x mm