

Name:

Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2020

Programme Name: B.Tech. Mechanical Engineering

Course Name : Instrumentation and Control

Course Code : ECEG3011

Nos. of page(s) : 03

Semester : V

Time : 03 hrs.

Max. Marks : 100

- Instructions: 1. Assume any missing data
2. Section B has an internal choice in Q.10.
3. Section C has an internal choice.**

SECTION A

(Answer in not more than 50 words)

S. No.		Marks	CO
Q 1	Discuss the components of a closed-loop control system.	5	CO1
Q 2	Describe the methods of performing frequency response analysis of control systems.	5	CO4
Q 3	A system is having the characteristic equation: $s^3 - 4s^2 + 2s + 7 = 0$. Using Routh's criterion state whether the system is stable or unstable. Write down the elements in the first column of the array. Find out the roots of the equation mathematically and then interpret your results.	5	CO5
Q 4	Discuss the steps of Nyquist stability criterion.	5	CO5
Q 5	Describe the various types of control systems.	5	CO1
Q 6	Discuss the various functional elements of a measurement system.	5	CO1

SECTION B

(Answer in not more than 150 words)

Q 7	Describe the working of a hydraulic servomotor.	10	CO2
Q 8	Discuss the various types of controllers that can be used in a feedback control system.	10	CO2
Q 9	For the level control system of Fig. 1, using a liquid system, derive expression relating h , p_1 and q . ' ρ ' is the mass density of the fluid, ' C ' is the capacitance and R_1 , R_2 , the fluid resistances. Express the liquid level ' h ' in terms of other parameters input.	10	CO3

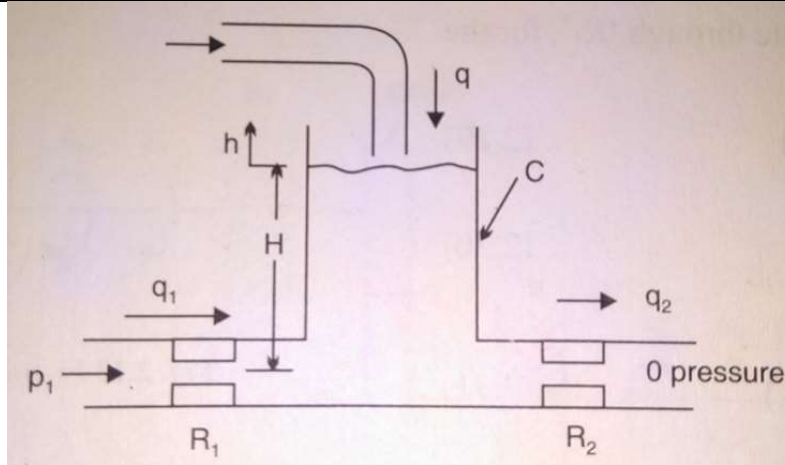


Fig. 1: Figure for Q. 9.

Q 10

a) For the system with block diagram as in Fig. 2,

$G = \frac{1}{10D^2 + 3D}$. If $K = 50$, $K_d = 1$, $K_i = 0.5$, find the steady state error when $r = 0$ and $b = 5$.

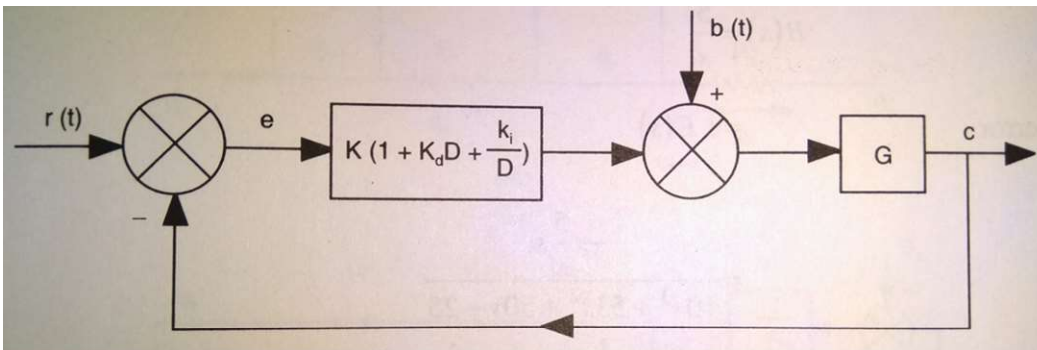


Fig. 2: Figure for Q. 10

OR

b) For the system shown in Fig. 2, find the steady state error when $r = 2$ and $b = 0$.

Q 11

Derive the transient response of a first order system subjected to a unit step input. Plot the output and input curves on a single graph. Discuss the results.

10

CO3

SECTION-C

Q 12

In the heat exchanger system shown in Fig. 3, steam flows through the pipes and heat is supplied to water. Thermal capacitances of pipes and tank are C_1 and C_2 respectively, R_1 is thermal resistance to heat flow between pipe and fluid and R_2 is the resistance to heat flow from the tank. If $q_{in} = K(\theta_i - \theta_c)/(9D+1)$, K being equal to 25, $D = d/dt$, $C_1 = 80$, $C_2 = 400$, $R_1 = 0.6$, $R_2 = 0.3$

- Draw block diagram
- Find governing equation relating θ_i , θ_c , θ_a .
- Find steady state error for unit step load change θ_a , while θ_i is unchanged

20

CO4

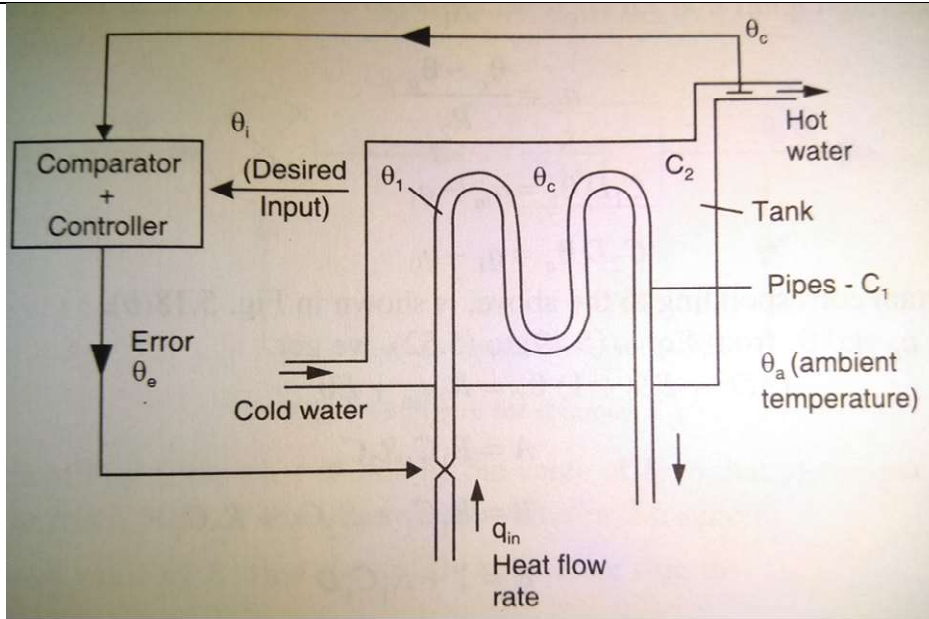


Fig. 3: Figure for Q. 12.

OR

(Internal Choice of Q. 12) Draw the closed-loop frequency response curve (polar plot) for the block diagram shown in Fig. 2. Take the physical parameters of the system as provided in Q. 10. Ignore disturbance $b(t)$.