

Seat No.: \_\_\_\_\_

Enrolment No. \_\_\_\_\_

**GUJARAT TECHNOLOGICAL UNIVERSITY**  
**BE - SEMESTER- 4 (NEW SYLLABUS) EXAMINATION- Winter- 2016**

**Subject Code: 2141004**

**Date: 22/11/2016**

**Subject Name: Control System Engineering**

**Time: 2.30 pm - 5.00 pm**

**Total Marks: 70**

**Instructions:**

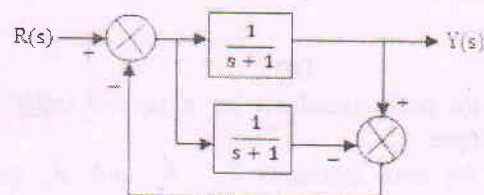
1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.

**Q.1**

**Short Questions**

**14**

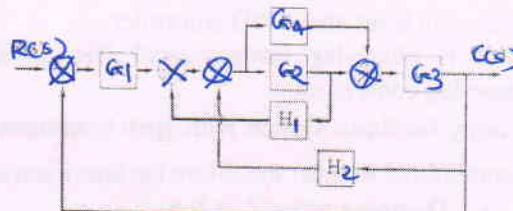
- 1 Define: Control system
- 2 In Force – Current analogy, Mass is analogous to \_\_\_\_\_.
- 3 List out the advantages of Phase-Lead Compensator.
- 4 State and explain sufficient and necessary condition for system stability.
- 5 Define: Rise time
- 6 Define: Steady state error
- 7 The response  $y(t)$  of the system with  $G(s) = \frac{1}{s}$  to a unit step input  $u(t)$  is \_\_\_\_\_. (Assume zero initial condition)
- 8 Find out a damping ration of a unity feedback system with  $G(s) = \frac{4}{s(s+2)}$ .
- 9 State the disadvantage of R-H criterion.
- 10 What is Gain margin?
- 11 The transfer function  $\frac{Y(s)}{R(s)}$  of the system shown is



- 12 Define with suitable example; Loop & Self loop.
- 13 Explain Break-away and Break-in point.
- 14 What is polar plot?

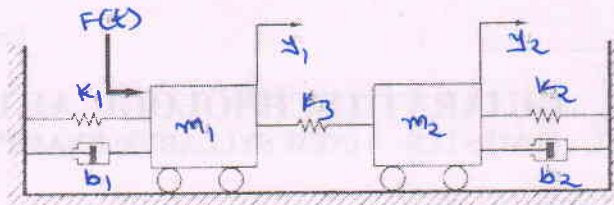
**Q.2**

- (a) Explain in brief difference between Open loop and Close loop control system. **03**
- (b) Explain Masson's gain formula with suitable example. **04**
- (c) Obtain system transfer function  $C(s)/R(s)$  using block diagram reduction technique for the system shown in figure, **07**

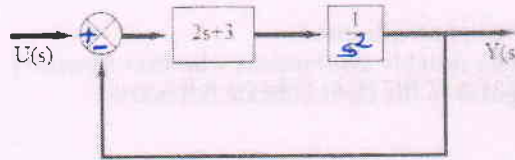


**OR**

- (c) A coupled spring-mass system shown in the figure. Obtain the differential equations describing the system. **07**

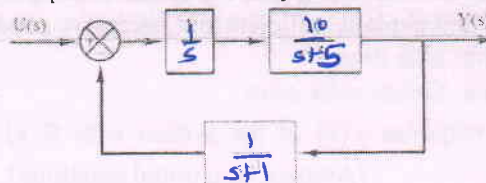


- Q.3 (a) Define: State, State variable, State trajectory 03  
 (b) Derive Correlation Between Transfer Function and State-Space model. 04  
 (c) Obtain a state-space model of the system shown in following figure. 07



OR

- Q.3 (a) Define: System sensitivity, Peak overshoot, Settling time 03  
 (b) Derive sensitivity  $s_G^T$  of open loop and close loop control system. 04  
 (c) Obtain a state-space representation of the system shown in figure. 07



- Q.4 (a) Derive the expression for Rise time for a second order control system subjected to a unit step input. 03  
 (b) Using Routh's criterion check the stability of a system whose characteristic equation is given by  $s^6 + 3s^5 + 5s^4 + 9s^3 + 8s^2 + 6s + 4 = 0$  04  
 (c) What is Root Locus? Draw the Root locus for a unity feedback system having  $G(s) = \frac{K}{s(s+1)(s+3)(s+5)}$  07

OR

- Q.4 (a) Derive the expression for peak overshoot for a second order control system subjected to a unit step input. 03  
 (b) Derive the expressions for error constants  $K_p$ ,  $K_v$  and  $K_a$  corresponding to step, ramp and parabolic input respectively. 04  
 (c) Draw the Nyquist plot for  $G(s) = 1/(s(s-1))$  and comment on system stability. 07  
 Q.5 (a) Define: Frequency response, Gain crossover frequency, Phase margin 03  
 (b) What is polar plot? Draw the polar plot considering a unity feedback system with open loop transfer function  $G(s) = \frac{10}{s(s+2)(s+5)}$  04  
 (c) State and explain compensator? Explain Phase-Lead compensator in detail. 07

OR

- Q.5 (a) Discuss in brief about PID controller. 03  
 (b) What is phase-lag compensator? Discuss advantages and disadvantages of phase-lag compensator. 04  
 (c) A unity feedback system with open loop transfer function  $G(s) = \frac{K}{s(s+2)}$  is to be compensated to meet the following specifications: 07  
 • Damping ration  $\xi = 0.5$   
 • Damped natural frequency  $\omega_n = 4 \text{ rad/sec}$   
 Design the lead compensator to meet the given specifications.

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