Seat No.: ________ Enrolment No.___________

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) - EXAMINATION – SUMMER 2017

Subject Code: 2141004 **Date: 06/06/2017**

Subject Name: Control System Engineering

Time: 10:30 AM to 01:00 PM **Total Marks: 70**

Instructions:

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

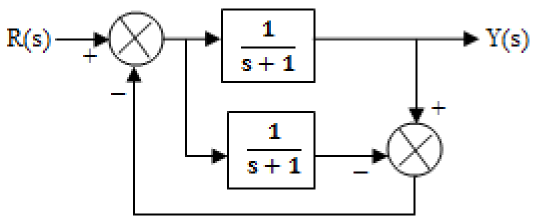
Q.1 **Do as directed (Short questions):** **14**

1 Define: Control system

2 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)

(A) $u(t)$ (B) $t\,u(t)$ (C) $\frac{t^2}{2}u(t)$ (D) $e^{-t}u(t)$

3 The transfer function $\frac{Y(s)}{R(s)}$ of the system shown is



(A) 0 (B) $\frac{1}{s+1}$ (C) $\frac{2}{s+1}$ (D) $\frac{2}{s+3}$

4 In Force – Voltage analogy, Mass is analogous to _____________.

5 _________ increases the steady state accuracy.

(A) Integrator (B) Differentiator

(C) Phase lag compensator (D) Phase lead compensator

6 A system having repeated roots on imaginary axis is ___________.

(A) Stable (B) Unstable (C) Marginally stable (D) Conditionally stable

7 The type-1 control system has ________ at the origin.

(A) One pole (B) One zero (C) Two poles (D) No pole

8 For type-2 control system K_p is _________ and K_v is _________.

(A) Constant, Constant (B) Infinite, Constant

(C) Zero, Constant (D) Constant, infinite

9 With feedback _____________ reduces.

(A) System stability (B) System gain

(C) System stability and gain (D) None of these

10 A unity feedback system with $G(s) = \frac{4}{s(s+2)}$ has damping ratio ________.

11 A system has its two poles on the negative real axis and one pair of poles lies on $j\omega$ axis. The system is ___________.

(A) Stable (B) Unstable (C) Marginally stable (D) Either A or C

12 A lag compensator is essentially a __________.

(A) Low pass filter (B) High pass filter

(C) Band pass filter (D) Either A or B

13 In a bode diagram (log magnitude plot) the factor $\frac{1}{j\omega}$ in the transfer function gives a line having slope ______ dB per octave.

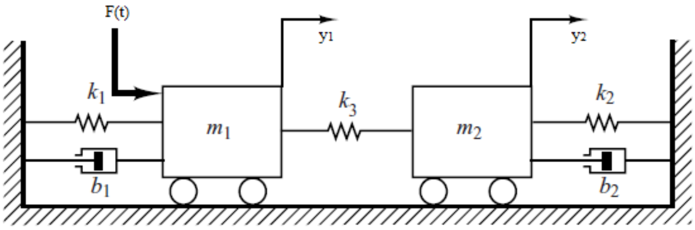
14 A system is _________ if output is bounded for the bounded input.

Q.2 **(a)** Consider a semi-automatic washing machine. **03**

(a) Is it an open loop system or closed loop system?
(b) Give reasons.
(c) What is the desired output of a washing machine?

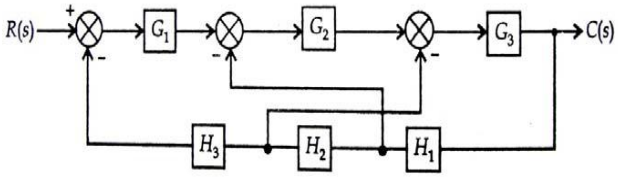
(b) State and explain Masson's gain foumula. **04**

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



OR

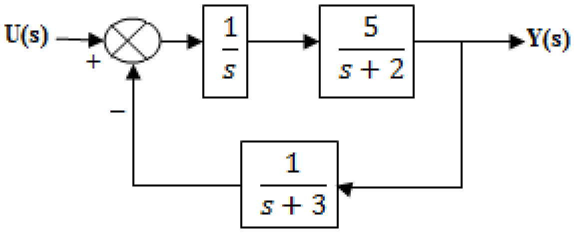
(c) Obtain system transfer function *C(s)/R(s)* using block diagram reduction technique for the system shown in figure, **07**



Q.3 **(a)** Define: Self loop, State, Peak time **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**

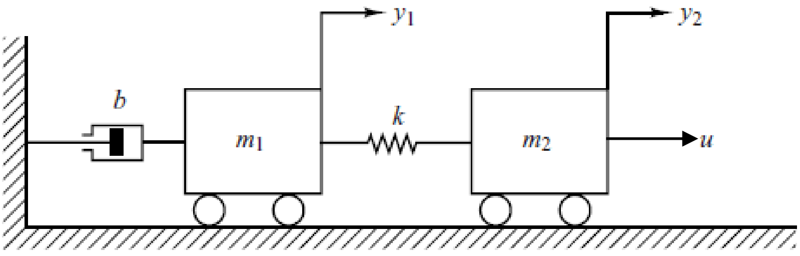


OR

Q.3 **(a)** Define: System sensitivity, State variable, 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 $s^5 + 2s^4 + 2s^3 + 4s^2 + 11s + 10 = 0$ **04**

(c) A unity feedback system has the loop transfer function $G(s) = \frac{K(s+2)}{s(s+1)}$ **07**

(a) Find the breakaway and entry points on the real axis.
(b) Sketch the Root Locus.
(c) Determine the gain K when the two characteristic roots have a $\xi = 0.707$.

OR

Q.4 **(a)** Derive the expression for peak overshoot for a second order control system subjected to a unit step input. **03**

(b) Define steady state error and derive the expressions for error constants K_p, K_v **04**

and K_a corresponding to step, ramp and parabolic input respectively.

(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 margin, 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 PD 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 $\omega_n = 4\ rad/sec$

Design the lead compensator to meet the given specifications.

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