

# JK LAKSHMIPAT UNIVERSITY, JAIPUR

## INSTITUTE OF ENGINEERING AND TECHNOLOGY

End Term Examination (Regular/Backlog), November 2016

B. Tech in .....EE & ECE..... Engineering, Semester V

Roll No.....

COURSE CODE: EE501

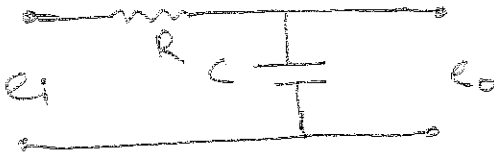
Time: 3 hours

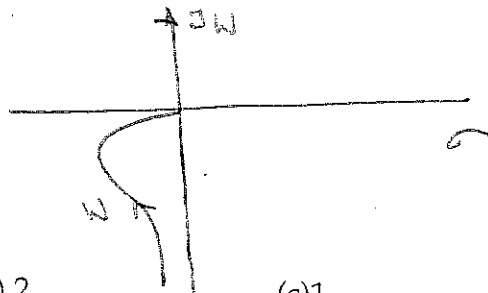
Max. Marks: 100

COURSE TITLE: Linear control systems

### Instructions to students:

1. Do not write anything other than your roll number on question paper.
2. Assume suitable data wherever required and mention it clearly.
3. Writing appropriate units, nomenclature, and drawing neat sketches/schematics/ flow chart wherever, required are an integral part of the answer.

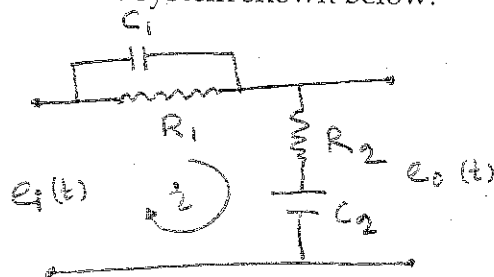
|      |                                                                                                                                                                                               |    |
|------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----|
| Q.1A | Objective type multiple choice questions (10 questions @ 1 mark)                                                                                                                              | 10 |
| i.   | A system having a transfer function $G(s) = \frac{1}{2(s+0.5)}$ is subjected to a unit step input; the steady value of the output is.....<br>(a) 1 (b) 2 (c) $\frac{1}{2}$ (d) $\frac{1}{10}$ |    |
| ii.  | The natural frequency of oscillations of the output for the equation $\frac{d^2x}{dt^2} + 1.5 \frac{dy}{dx} + 4x = 1$ is .....<br>(a) 0 rad/sec (b) 1.5 rad/sec (c) 2 rad/sec (d) 4 rad/sec   |    |
| iii. | The transfer function for the network given below:<br>                                                     |    |
|      | (a) $\frac{1}{RCs+1}$ (b) $RCs + 1$ (c) $\frac{1}{\frac{R}{C}s+1}$ (d) $\frac{R}{C}s + 1$                                                                                                     |    |
| iv.  | For the system $\frac{C(s)}{R(s)} = \frac{16}{s^2+8s+16}$ . The nature of the time response will be<br>(a) Overdamped<br>(b) Underdamped<br>(c) Critically damped<br>(d) None of these        |    |
| v.   | The open loop transfer function of a feedback system is given below:<br>$G(s)H(s) = \frac{K}{s(s+10)}$<br>The value of gain factor K for critical damping is<br>(a) 10 (b) 15 (c) 20 (d) 25   |    |
| vi.  | The damping ratio of a second order control system is increased from 0.3 to 0.6, the corresponding change in the % overshoot is.....<br>(a) 37.08% to 9.47% (b) 9.47% to 37.08%               |    |

|       |                                                                                                                                                                      |                       |                           |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------|
|       | (c) 60% to 30%                                                                                                                                                       | (d) 20% to 50%        |                           |
| vii.  | The steady state error for an input $2u(t)$ applied to a type 0 system is .....                                                                                      |                       |                           |
|       | (a) $\frac{1}{2(1+K_p)}$                                                                                                                                             | (b) $\frac{2}{1+K_p}$ | (c) $\frac{1}{K_p}$ (d) 0 |
| viii. | The order of the differential equation governing a system having its polar plot is shown below:                                                                      |                       |                           |
|       |                                                                                    |                       |                           |
|       | Is (a) 3                                                                                                                                                             | (b) 2                 | (c) 1 (d) 0               |
| ix.   | For a stable system                                                                                                                                                  |                       |                           |
|       | (a) G.M. and P.M. both are positive<br>(b) G.M. and P.M. both are negative<br>(c) G.M. is positive and P.M. is negative<br>(d) G.M. is negative and P.M. is positive |                       |                           |
| x.    | If the root locus branches cross the imaginary axis the system becomes                                                                                               |                       |                           |
|       | (a) Over damped<br>(b) Critically damped<br>(c) Stable<br>(d) unstable                                                                                               |                       |                           |

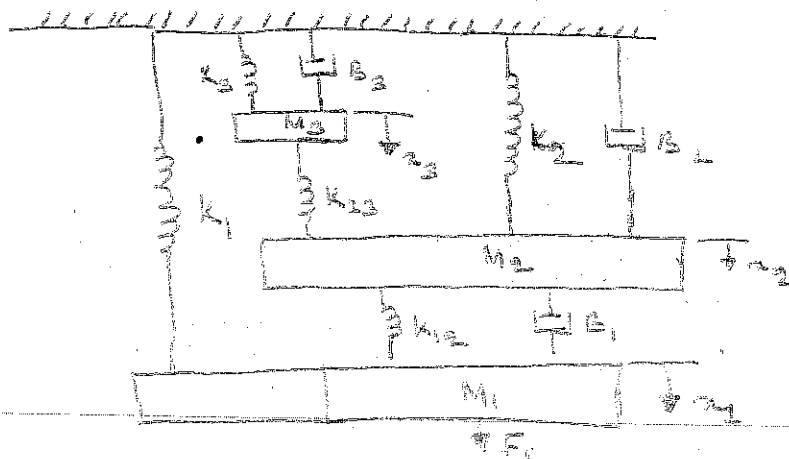
Q.2 Short answer type questions (4 questions @ 2.5 marks)

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- With block diagram compare open loop system with closed loop system.
- Determine the transfer for the system shown below.



- Determine the mathematical model equations for a mechanical system shown below.



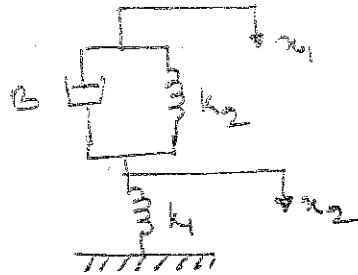
iv. What is principle of argument?

Q.3A What are the different forces & torques that resist motion in translational and rotational systems discuss with diagram.

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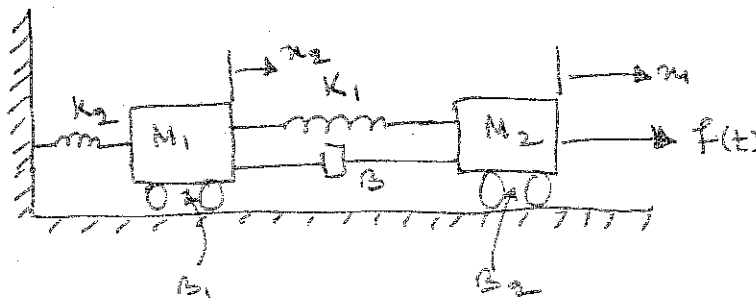
Q.3B Draw the electrical analogous circuit (use f-v) analogy and derive their transfer functions.

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Q.4A Determine the transfer function relating  $x_1(s)$  to  $F(s)$  for the mechanical system shown below.

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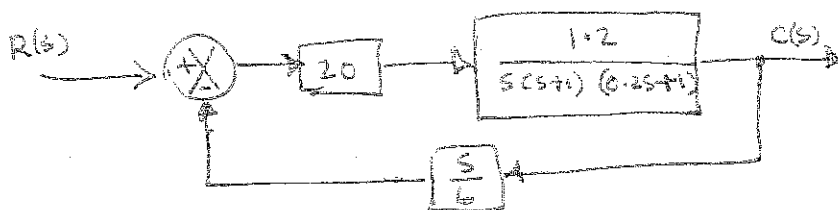


Q.4B Describe all the static error coefficients.

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Q.5A The bloc diagram of a simple servo system shown in given fig below.

05



Find-

- (i) Undamped frequency of oscillations
- (ii) Damped frequency of oscillations
- (iii) damping ratio, damping factor
- (iv) maximum overshoot, first undershoot
- (v) settling time

Q.5B Discuss the advantages and disadvantages of feedback with special reference to

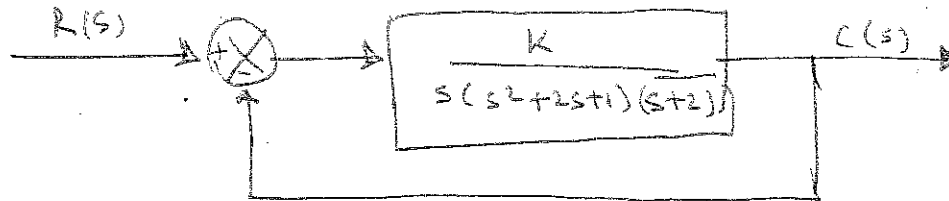
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- (i) Reduction of parameter variation

- (ii) Control over system dynamics  
(iii) Gain

Q.6A Find the range of  $K$  to keep the system shown in the figure below stable.

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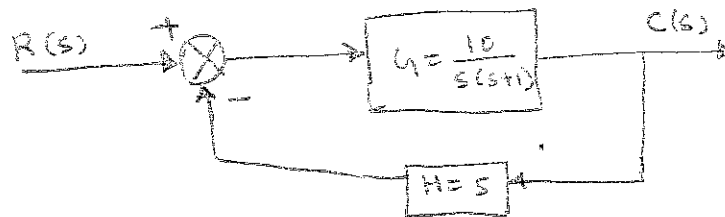
Q.6B Describe all the design specifications in frequency domain.

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OR

Q.6B For the system shown in the figure given below, calculate the sensitivity of the closed loop transfer function w.r.t to  $G$  and  $H$  for  $\omega = 1 \text{ rad/sec}$ .

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Q.7A Write a short note on A.C. servo motor.

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Q.7B The open loop transfer function of a control system is given below:

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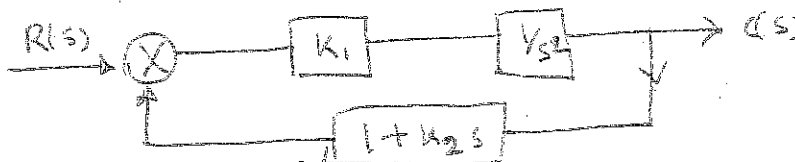
$$G(s) = \frac{3(s^2 + 5s + 10)}{s(s + 1)(s^2 + 4s + 10)}$$

Determine the static error constants and steady state errors.

OR

Q.7B For the control system shown below, find the values of  $K_1$  and  $K_2$  so that  $M_p = 25\%$  and  $T_p = 4 \text{ sec}$ . Assume unit step input.

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Q.8A By Nyquist stability criterion determine the stability of closed loop system, whose open loop transfer function is given by,

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$$G(s)H(s) = \frac{20}{(s+1)(s+1)}$$

Comment on the stability of open-loop and closed loop system.

Q.9A A unity feedback control system has an open loop transfer function

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$$G(s) = \frac{K}{(s^2 + 4s + 13)}$$

Sketch the root locus.

Q.9B

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Draw the bode plot for the transfer function

$$G(s) = \frac{50}{s(1 + 0.25s)(1 + 0.1s)}$$

From the graph determine

1. Gain crossover frequency
2. Phase crossover frequency
3. G.M and P.M.
4. Stability of the system

OR

Q.9B (i) Draw the signal flow graph of the system and determine the transfer function by mason's gain formula  
(ii) Determine the transfer function  $C(s)/R(s)$  of the system using bloc diagram reduction technique.

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