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JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -2 EXAMINATION- December 2017

B. Tech VIIth Semester

COURSE CODE: 17B1WEC733 MAX. MARKS: 35

COURSE NAME: **ROBOTIC SYSTEMS AND CONTROL**

COURSE CREDITS: 3 MAX. TIME: 2hrs

Note: *All questions are compulsory. Carrying of mobile phone during examinations will be treated as case of unfair means.* ***Make valid assumptions if required.***

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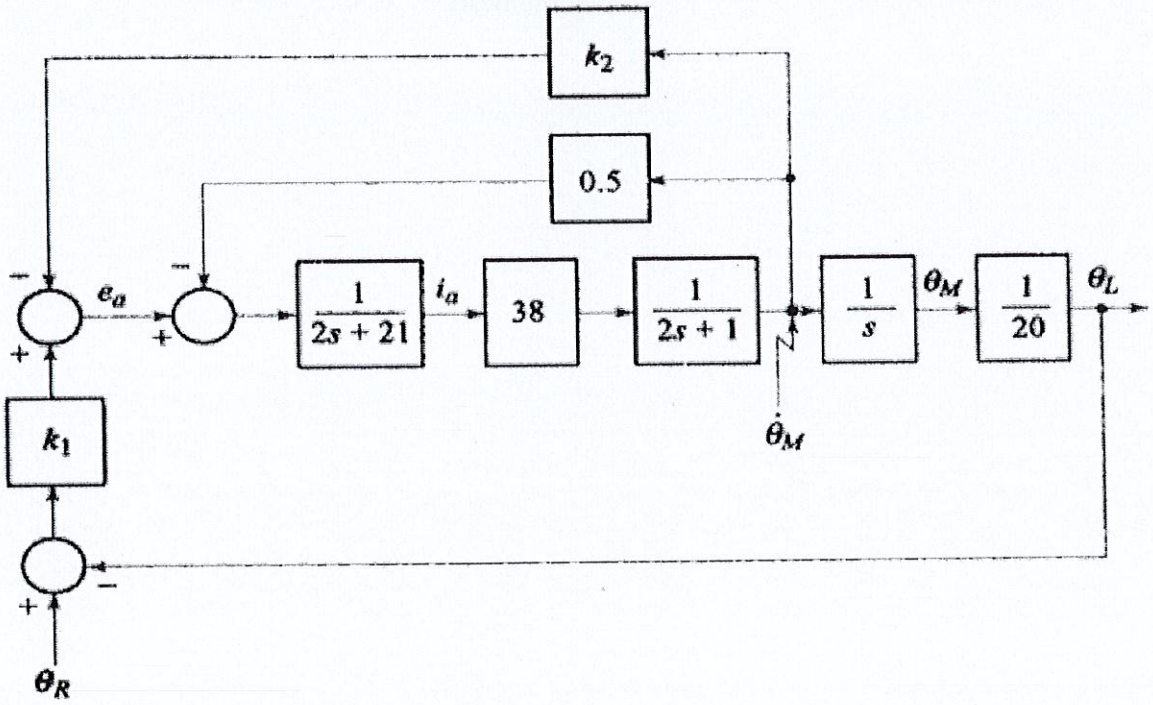
1. **[8 marks] Figure given below shows the block diagram of a motor-driven, single-link robot manipulator with position and velocity feedback. The drive motor is an armature-controlled dc motor; e_a is armature voltage, i_a is armature current, θ_m is the motor shaft position and $\dot{\theta}_m$ is motor shaft velocity. θ_L is the position of the robot arm. Taking $\theta_m, \dot{\theta}_m, i_a$ as state variables, derive a state model for the feedback system.**



2. **[10 marks] Derive the mathematical model of the PMDC motor. Design a PD compensator for the regulation problem of robot manipulator.**

   Consider the second order system whose characteristic polynomial is $p(s) = s^2 + (1 + K_D)s + K_P$. Suppose $\theta^d = 10$ and there is no disturbance (d=0). Find the required PD gains for robotic application and check the performance of the closed-loop system.

3. **[10 marks] A regulator system has the plant**

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u;\ y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

a) **Design a state-feedback controller which will place the closed-loop poles at $-2 \pm j3.464, -5$. Give a block diagram of the control configuration.**

b) **Design a full-order state observer; the observer-error poles are required to be located at $-2 \pm j3.464, -5$. Give all the relevant observer equations and a block diagram description of the observer structure.**

4. **[7 marks] Prove that the feedforward control results in asymptotic tracking of any trajectory in the absence of disturbances. What is the control method used to improve the disturbance rejection properties of the system. Draw a suitable block diagram of feedforward disturbance cancellation scheme.**

All the Best!