JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATION- Dec 2017

B. Tech Vth Semester

COURSE CODE: 10B1WEC515 MAX. MARKS: 35

COURSE NAME: **Theory and Application of Control Systems**

COURSE CREDITS: 4 MAX. TIME: 2hrs

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*Note: **All questions are compulsory.***

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1. **[10 marks]** Consider the system

$$\dot{x} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix} u;\ y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x$$

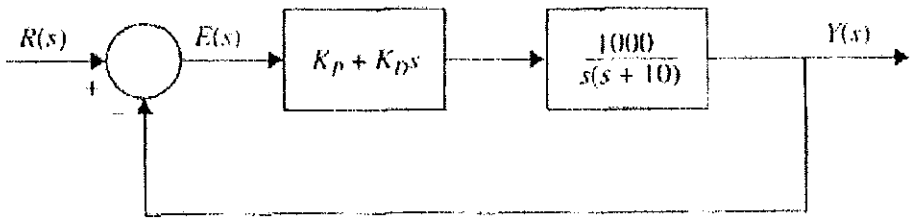
   a. Find the eigenvalues of A and from there determine the stability of the system.
   b. Find the transfer function model and from there determine the stability of the system.
   c. Are the two results same? If not, why?

2. **[6 marks]** Consider a double-integrator plant described by the differential equation

$$\frac{d^2\theta(t)}{dt^2} = u(t)$$

   a. Develop a state equation for this system with u as input, θ *and* $\dot{\theta}$ as the state variables x_1 *and* x_2 respectively.
   b. Investigate the controllability and observability properties of this model.

3. **[5 marks]** A control system with a PD controller is shown in below figure.



   Find the values of Kp and KD so that the ramp-error constant Kv is 1000 and damping ratio is 0.5.

4. **[6 marks]** State the Nyquist stability criterion and check the stability of a feedback system whose open-loop transfer function is given by

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

5. **[2 marks each]** Write Short Notes on:

a) Gain margin and Phase margin
b) Mason's gain formulae
c) Transfer function vs. State-space approach
d) Routh-Hurwitz vs Root locus method