BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: MTECH/PRE-PHD **SEMESTER : I / NA**
BRANCH: EEE **SESSION : MO/18**

SUBJECT: EE515 CONTROL SYSTEM DESIGN
TIME: 3:00 HRS. **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

Q.1(a) List the disadvantages of a one degree of freedom controller as compared with a two degree of freedom controller? List down two limitations for a Single-Stage phase-lead and two limitations for a Single-Stage-Phase-lag Control. [5]

Q.1(b) What are the benefits of Minor Loop feedback control over conventional PD controller? List down the limitations of pole zero cancellation design. [5]

Q.2(a) Describe the complete design procedure for a lead compensator using frequency response approach with appropriate phase attenuation formulae and also draw a neat Bode diagram for lead compensator, uncompensated, and compensated system under the same figure. [5]

Q.2(b) Controlled plant of a unity-feedback system is $G(s) = 1/(s^2 + 1)$. Design a PD controller such that the dominant closed loop poles satisfy the specifications (overshoot<=16.30%, settling time <=4 sec). What is the position-error constant of the compensated system? If it is desired to reduce the steady-state error to step inputs to zero, then suggest the design of a PID controller that meets the requirements on both the transient and the steady-state performance? [5]

Q.3(a) For the plant described by the open loop T.F $G(s) = 10/(s*(s+4))$, design a lag compensator such that the static velocity error constant K_v is $25\ \text{sec}^{-1}$ without appreciably changing the original location ($s = -2 \pm j2.45$ of a pair of complex-conjugate closed loop poles. Compute the closed loop transfer function of the system. [5]

Q.3(b) Define robustness of a closed loop system. List down different performance specifications or design objectives to achieve robustness of a system. [5]

Q.4(a) A servo system has the plant with integrating property, described by the equation, [5]

$$\dot{\mathbf{x}} = \mathbf{A}\mathbf{x} + \mathbf{b}u$$

$$y = \mathbf{c}\mathbf{x}$$

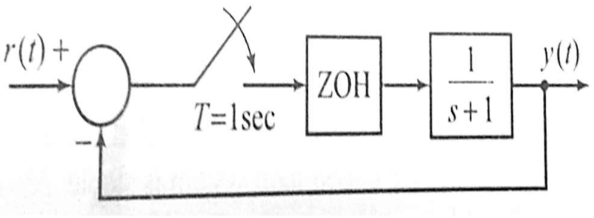
where

$$\mathbf{A} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & 0 & -2 \end{bmatrix}; \mathbf{b} = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}; \mathbf{c} = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$$

If $u = -Kx + Nr$, compute K and N so that the closed-loop poles are located at ($-1 \pm j1$, -2) and $y(\infty) = r$, a constant reference input.

Q.4(b) What is separation principle and derive the mathematical expression that proves that this principle holds good for the reduced order observer? [5]

Q.5(a) For the sampled-data system shown below, compute the response $y(kT)$; $k = 0, 1, 2, \ldots\ldots$, to a unit step input $r(t)$. [5]



Q.5(b) The digital process of a unity feedback system is described by the open loop transfer function $G_{h0}G(z) = \frac{K(z+0.717)}{(z-1)(z-0.368)}$; $T = 0.5sec.$ Sketch the root-locus for 0<=K<=∞ and find the value of 'K' that result in marginal stability. [5]

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