E-/SEM V(CBSGS)/INST./MAY 2018
Controls System Design

Duration: 3 Hours **Q. P. Code: 35998**

Max. Marks 80

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four**

a. Obtain the state space representation for following system in diagonal form **20**

$$G(s) = \frac{4}{s^2 + 2s - 3}$$

b. Prove that–'eigen values of the system matrix are invariant under linear transformation'.

c. What is lead compensator? Why it is required?

d. Compute the modal matrix for diagonalization of

$$A = \begin{bmatrix} 1 & 3 \\ 0 & -1 \end{bmatrix}$$

e. Define controllability and observability of the system.

f. For the open loop system

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

Calculate required phase angle contribution by the compensator if desired closed loop poles are $s_d = -0.7 \pm 0.4j$. Which compensator will you suggest?

Q.2 A. Check for the stabilizability and detectability of the system, **10**

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 5 & 1 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 3 \\ 0 \end{bmatrix} u \\ y &= [1.5 \;\; 0 \;\; 1]\, x \end{aligned}$$

B. Represent the following system into Jordan canonical form **10**

$$G(s) = \frac{0.5s^2 + 2s - 2.5}{s^3 - s^2 - 5s - 3}$$

Q.3 A. Design the series lead compensator using bode plot for the system in Figure 1 to achieve velocity error constant $K_v = 20sec^{-1}$, phase margin $PM \geq 50^0$ and gain margin $GM \geq 10dB$. **10**

B. Draw typical circuit diagram and corresponding transfer function for lag compensator. Write the steps to design lag compensator using root-locus. **10**

Q.4 A. Design the state feedback control for the system 10

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

to place the poles at $-1, -2.5$.

B. Compute state transition matrix for the system, 10

$$\dot{x} = \begin{bmatrix} -2 & 0 \\ 0 & 3 \end{bmatrix} x$$

Q.5 A. Obtain the transfer function matrix for the system 10

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -1.6 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} x$$

B. A system is given by 10

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = [1 \ 0] x$$

Design the observer that has poles at $-25, -30$.

Q.6 Write short notes on 20

A. Cohen-coon method for PID controller tuning.

B. Lag-lead compensator.

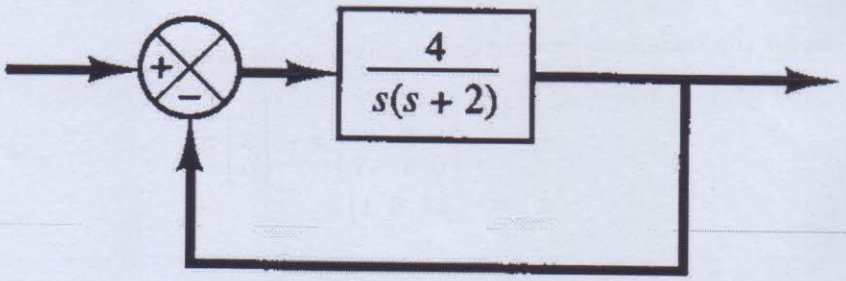

Figure 1:

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May 2018

Q. P. Code : 38425

Note: 1. Question no. 1 is compulsory

2. Attempt any **three** questions from remaining **five** questions

3. Figures to the right indicate full marks

4. Assume suitable data whenever necessary

Duration: 03 hours Marks: 80

Q.1. a. Explain the terms Signal level and bias changes, filtering and impedance matching.

b. Draw and explain circuit diagram of zero crossing detector. 20

b. Explain the characteristics of digital data.

c. Design a high-impedance amplifier with a voltage gain of 42.

d. The resistors in a bridge are given by $R_1 = R_2 = R_3 = 120\Omega$ and $R_4 = 121\Omega$. If the supply is 10.0V, find the voltage offset.

Q.2. a. What is the need for 3 op-amp instrumentation amplifier? Mention the applications of instrumentation amplifier. Explain any one in detail. 10

b. What are the advantages of active filters over passive filters? Design a second-order low-pass filter at a high cut off frequency of 1 kHz. 10

Q.3. a. Draw and explain circuit for ideal differentiator with waveforms. Discuss the problems associated with ideal differentiator and draw the circuit diagram for practical differentiator. 10

b. Draw and explain circuit diagram of absolute value circuit using op-amp and sketch the input and output waveforms. Discuss its advantages over traditional diode rectifier. 10

Q. 4. A sensor resistance changes linearly from 100 to 180Ω as temperature changes from 20° to 120°C. Find a linear equation relating resistance and temperature. 10

b. Draw and explain the principle and construction of metal strain gauges. What is the signal conditioning associated with it. 10

Q.5. a. Design and explain operation of Astable multivibrator using IC555. 10

b. A CdS cell has a dark resistance of 100kΩ and a resistance in a light beam of 30kΩ.The cell time constant is 72ms. Devise a system to trigger a 3-V comparator within 10ms of the beam interruption. 10

Q.6. Write short notes on: (any four) 20

a. Sample and hold circuit b. PLL c. Voltage regulator IC 723

d. Data Acquisition System e. SMPS f. Weighted resistor DAC

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Control System Components

Q.P. Code :20957

[Time: Three Hours] **[Marks:80]**

Please check whether you have got the right question paper.

N.B:
1. Question.No.1 is compulsory.
2. Attempt any three questions from Q.No.2 to Q.No.6.
3. Draw suitable diagram wherever required.

Attempt **any five**. 20

a. Compare SMART vs. conventional transmitter.
b. Explain operation of three way solenoid valve.
c. Explain in brief Alarm Annunciator system.
d. Give Comparison between Pneumatic, Hydraulic and Electrical system.
e. What is ATC & ATO? Explain in brief.
f. With suitable diagram explain Rupture Disk.

a. What is Control Valve? Explain sliding stem Globe control value. 10
b. Explain with suitable sketch working of I to P converter. 10

a. Explain classification of Process Transmitters. Discuss Operation of DP Transmitter with suitable application. 10
b. With suitable sketch explain Air Compressor system. 10

a. What is Valve Positioner? Explain with suitable sketch working of Force balance Valve Positioner 10
b. Explain construction, working and application of single and double acting cylinders. 10

a. Explain in brief any two Auxiliary Process control components and their applications. 10
b. With suitable diagrams explain working of 2/2 directional control valve. 10

Write a short note on: 20

a. Hydraulic pump
b. Instrument and Plant Air
c. Contactor Vs Relay
d. Types of Actuators

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