Code No: R22026 **R10** SET - 1

II B. Tech II Semester Supplementary Examinations Dec – 2012
CONTROL SYSTEMS
(Com. to EEE, ECE, EIE, ECC, AE)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Compare open loop and closed loop control systems.
   b) Clearly bring out, from basics, Force-current and Force-Voltage analogies.

2. a) Derive the transfer function of armature controlled DC Servo motor.
   b) Explain, in detail the use of synchro as error detector.

3. a) What are the 'standard test signals' used in the analysis of system performance? Explain.
   b) Derive the expressions for i) overshoot ii) rise time and iii) peak time of a prototype second order system.

4. a) Briefly explain the Root Locus concept.
   b) Determine the range of 'K' for which the system having the characteristic equation: $s^4+20Ks^3+5s^2+10s+15=0$ is stable.

5. Sketch the Bode plots for the transfer function G(s) = $\frac{1000}{(1+0.1s)(1+0.001s)}$ Determine
   i) the phase margin ii) the gain margin and iii) the stability of the system.

6. The open loop transfer function of a unity feedback system is G(s) = $\frac{K}{s(1+sT)\,(1+s\tau)}$. Derive an expression in terms of the two time constants and the specified gain margin based on the Nyquist criterion for stability.

7. Design a suitable lag compensating network for G(s) = $\frac{K}{s(s+2)(s+20)}$ to meet the following specifications: $K_v=20\ sec^{-1}$ and $PM \geq 35^0$.

8. a) Explain the concepts of i) state ii) state variables iii) state model, and iv) controllability.
   b) A state variable formulation of a system has the standard state and output equations with A, B and C matrices given as $A=\begin{bmatrix}1 & 0\\ 0 & -1\end{bmatrix}$; $B=\begin{bmatrix}0\\ 1\end{bmatrix}$ *and* $C=\begin{bmatrix}1 & 1\end{bmatrix}$. What is the transfer function of the system?
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Code No: R22026 **R10** SET - 2

II B. Tech II Semester Supplementary Examinations Dec – 2012
CONTROL SYSTEMS
(Com. to EEE, ECE, EIE, ECC, AE)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) With the help of neat diagrams, explain the working of any two practical examples for closed loop control systems.
   b) What is the importance of 'impulse response' in system studies? How is a transfer function obtained for a given physical system? How is it related to the impulse response?

2. a) Derive the most simplified transfer function of an A.C. Servo motor stating all the assumptions made.
   b) Explain the working of a synchro transmitter receiver pair.

3. a) For a typical first order transfer function, derive the expression for unit step response. Hence define 'time constant', and 'settling time'. Sketch the response indicating all salient features.
   b) What are the important time domain specifications considered for analysis and design of systems? Define each of them with respect to prototype second order system. Give the expressions and mention the significance of each quantity in the expressions.

4. a) What are the effects of adding i) pole ii) zero to G(s)H(s) on the root loci?
   b) The characteristic equation of a control system is: $s^4+Ks^3+2s^2+s+3=0$. Show that there is no value of K for which the system is stable.

5. A unity feedback control system has a forward transfer function $\frac{25}{s(s+6)}$ Find the resonant peak and the corresponding frequency for the closed loop response. Derive the formulae used.

6. For the transfer function G(s)H(s)= $\frac{K(s+2)}{s(s+1)(s-3)}$, sketch the Nyquist plot and determine whether the system is stable or not.

7. What are the various types of compensating schemes used in control systems? Explain the concept of cascade lead compensator of control systems with the help of an example.

8. A system is described by $\dot{X} = \begin{bmatrix} -1 & -4 & -1 \\ -1 & -6 & -2 \\ -1 & -2 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u; y = \begin{bmatrix} 1 & 1 & 1 \end{bmatrix} X$. Find the transfer function that describes the system.
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Code No: R22026 **R10** SET - 3

II B. Tech II Semester Supplementary Examinations Dec – 2012
CONTROL SYSTEMS
(Com. to EEE, ECE, EIE, ECC, AE)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Explain the various ways of classifying control systems.
   b) Discuss the effects of feedback on i) sensitivity ii) stability iii) overall gain, and iv) dynamic performance.

2. a) Draw the signal flow graph for the following equations:
   i) $x_1+5x_2-2x_3=0$ ii) $x_3+2x_4-4x_2=0$ iii) $x_4-8x_3=0$.
   b) How are the rules of block diagram algebra applied for making the following changes?
   i) Eliminating the feedback loop ii) eliminating a forward loop iii) moving a take-off point beyond a block and iv) moving a summing point beyond a block.

3. a) Draw a neat sketch of the unit step response of prototype under damped second order system, indicating all important quantities and salient features. Distinguish between the 'transient response' and 'steady state response'.
   b) The open loop transfer function of a unity feedback system is given by G(s) = $\frac{50}{(1+0.1s)\,(s+10)}$. Determine the i) position error constant ii) velocity error constant, and iii) acceleration error constant.

4. a) Apply the angle condition to determine whether the point $s=-2+j2$ is on the root locus plot for $s(s+2)+K(s+4)=0$.If it is, then determine the value of K at this point and the factored form of the characteristic equation.
   b) Justify the statement: 'root locus is symmetrical about the real axis'.
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5. a) The forward path transfer function of a unity feedback control system is $G(s) = \frac{100}{s(s+6.54)}$

   Find the resonant peak, resonant frequency, and bandwidth of the closed loop system.

   b) Explain how gain margin and phase margin can be determined from the Bode plots.

6. a) Explain the 'Nyquist stability criterion'.

   b) A unity feedback system has open loop transfer function $G(s) = \frac{1}{s(1+2s)(1+s)}$. Sketch the Nyquist plot for the system and obtain the gain margin and the phase margin.

7. The open loop transfer function of a type 2 system with unity feedback is given by $G(S) = \frac{K}{s^2(1+0.25s)}$. Design a lead compensator to meet the following specifications:

   i) Acceleration error constant =10, and ii) phase margin =35^o.

8. a) Compare 'classical approach' and 'modern approach' for control system analysis and design.

   b) What do you understand by 'state transition matrix'? State and prove its properties.

Code No: R22026 **R10** SET - 4

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Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions
All Questions carry **Equal** Marks
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1. a) Explain the merits and demerits of i) open loop control systems ii) closed loop control systems.
   b) What are the three types of forces that resist translatory motion? What are the three types of torques that resist rotational motion? Explain in detail with the support of necessary equations.

2. a) Explain the constructional details and principle of operation of A.C Servo motor.
   b) For the system represented by the following equations, find the transfer function using signal flow graph. Take u as the input and x as the output.
   i) $x = x_1 + \beta_3 u$ ii) $x_1 = -a_1 x_1 + x_2 + \beta_2 u$ iii) $x_2 = -a_2 x_1 \beta_1 u$

3. a) A closed loop servo system is represented by the differential equation $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$ where c is the displacement of the output shaft, r is the displacement of the input shaft and $e = r\text{-}c$. Determine i) damping ratio ii) damped natural frequency, and iii) percentage peak overshoot.
   b) Derive the expressions for steady state error of type 0 system to i) unit step input ii) unit ramp input.

4. a) The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$ what value of K causes sustained oscillations in the closed loop system? What is the frequency of these oscillations? Apply R-H criterion.
   b) What do you understand by 'angle criterion' and 'magnitude criterion' with respect to root locus concept? Explain.
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5. Draw the Bode plots to determine the values of K for open loop transfer function $G(s)H(s) = \frac{K}{s(1+0.1s)(1+s)}$ so that i) the gain margin is 15dB, and ii) the phase margin is 60^0.

6. a) What do you understand by 'critical point' on the Nyquist plot'? How are the following read from the Nyquist plot? (i) Phase cross over frequency (ii) gain cross over frequency (iii) Phase margin (iv) gain margin.

   b) Using Nyquist criterion, determine the stability of the feedback system which has the following open loop transfer function: $G(s)H(s) = \frac{K}{s^2(1+sT)}$

7. a) Draw the characteristic Bode plots of i) lag compensator ii) lead compensator, and iii) lag-lead compensator. Give the procedural steps for lag compensator design.

   b) Explain the effects of proportional, integral, and derivative terms of PID controllers on system performance.

8. a) Obtain the solution for the standard non homogeneous state equation.

   b) What do you understand by 'controllability' of a system? Derive the condition for controllability.