EEL301:

Major Examination 8th May 2007

Part – A

Note: The question paper contains two parts, A and B.
Part A: This sheet – three questions - 35 marks
Part B: To be given (1 Hr later) – 3X 15 = 45 marks, 1 Hr.

Q1. For the transfer function 15

$$G(s) = (s+500)/\{s(s^2+10s+100)\}$$

a. Write the accurate expression of the *Magnitude* in decibels. 3
b. Write the approximate expressions for the magnitude in decibels in different ranges of the sinusoidal frequency 4
c. Sketch the asymptotic Bode *Magnitude* plot only, but clearly showing the relevant corner frequencies, slopes and the point of intersection with the vertical axis (y-intercept). 8

Q2. A unity feedback closed loop system has the forward path transfer function 10

$$G(s) = (s+5)/\{(s+1)(s+3)(s+10)\}$$

Obtain the complete root-locus for the closed loop system, clearly obtaining and showing the imaginary –axis crossing if any, asymptotic lines for branches going to infinity if any, break-in or break-off points if any (in case you can not solve for accurate value, show approximate representative location with an identified range), in addition to starting and ending points.

Q3. A state-space system has 10

$$A = \begin{bmatrix} -1 & 0 \\ 0 & 2 \end{bmatrix} \; ; \quad \text{and} \quad B = \begin{bmatrix} -1 \\ 0 \end{bmatrix}$$

The matrix A has its eigenvalues as –1 and 2, with corresponding eigenvectors

$$v_1 = [\,1\;0\,]^T \text{ and } v_2 = [\,-1\;2\,]^T$$

a. Obtain a modal decomposition of the system 2
b. Identify any uncontrollable that exist, if any 3
c. In case it exists, suggest a change in B that would make system controllable. If not, just say no change required. 5

Each Question = 3 marks.
Correct = ,,
Wrong = -1 marks

PART –B

1. For a closed loop 2-order system the gain is varied, for which the two poles move straight vertically upward and downward parallel to the imaginary axis. Therefore
   a. Settling time remains fixed
   b. Damping ratio remains fixed
   c. Natural Frequency remains fixed
   d. None of the above remains fixed

2. A 2nd order system is such that its damped freq. of oscillation is $1/\sqrt{2}$.times its natural freq. Then the % overshoot is
   a. $e^{-\pi}$ b. e^{-1} c. $e^{-\pi/2}$ d. None of these

3. A state system is given by a A, B, C, and D=0. There exists a matrix P such that
   $P^{-1}AP =$ and $P^{-1}B =$;

   The transfer function of the system can be
   a. s/{(s+4)(s+5)} b. 1/{(s+4)(s+5)} c. 1/{(s+2)(s-3)} d. Can not be said

4. The system given in the previous problem is
   a. Unstable b. Stable c. Uncontrollable d. Marginally stable

5. A standard mass-spring system has a single mass M=1/2 and a nonlinear spring with force-displacement curve being $F = 2x^3+3x$ How many physically meaningful equilibrium points does it have?
   a. 1 b. 2. c. 3 d. 0

6. An LTI system with transfer function $G(s) = 9/(s^2+2s+9)$ is excited by an input $r(t) = 5 \sin 100t$. At steady state, the frequency of the output is
   a. 3 Hz b. 6Hz c. 50 Hz. d. Harmonics of 50 Hz, 10 Hz etc.

7. A feedback system with $G(s) = 1/(s+a)$ and $H(s) = 1/s$ is excited by a unit-step inout. The steady state value of the *output* is
   a. 0 b. 1 c. 1/a d. None of these

8. Auxiliary polynomial o the Routh Array gives
   a. Poles on imaginary axis only
   b. Unstable poles only
   c. Stable poles only
   d. None of these

9. For the state-space system $A = \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}$; $B = \begin{bmatrix} -1 \\ -2 \end{bmatrix}$; $C = [1 \;\; 0]$ and D=0,

   If the output y(t) is completely given for all t>0, then the state x(t) at t=0 can be computed completely.
   a. False b. True c. Can not be said d. True iff D > 0

10. A transfer function whose denominator higher in degree that in numerator is called
   a. Stable   b. Proper.   c. Well-posed   d. Non-singular

11. A row entirely of zeroes in a Routh-Hurwitz array indicates
   a. Poles located symmetrically about the real axis
   b. Poles located symmetrically about the imaginary axis
   c. Poles located symmetrically about the origin.
   d. Poles located co-incidentally on some points (Repeated roots)

12. A lead compensator is generally used to improve
   a. The steady state response
   b. The transient response
   c. The position error constant
   d. None of these

13. Two transfer functions having same low-frequency characteristics are likely to have
   a. Similar transient responses   b. Similar steady state response
   c. No possible relation between freq. and time responses
   d. Similar response to noise-signals

14. In the context of a 2nd order system and its root locus, the break-off /break-in points correspond to
   a. Critical damping   b. Transition between instability and stability
   c Undamped system   d. None of these.

15. A matrix A has eigenvalues –2 and –5. Then the eigenvalues of e^A are
   a. +2 & + 5   b. –7 and 10   c. e^{-2} & e^{-5} d. No such relation

   b.
