Vehicular Electronics HW3

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All code is written in matlab.

**Q3.**

**Description**

Use matlab to solve reduce formula.

inv function to calulate inverse matrix.

ilaplace function to calculate inverse lapacian.

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| --- |
| syms s  invmat = inv( [ s, -1; 2, s+3 ] )  ans = ilaplace(invmat) |

|  |
| --- |
| >> hw3  invmat =    [ (s + 3)/(s^2 + 3\*s + 2), 1/(s^2 + 3\*s + 2)]  [ -2/(s^2 + 3\*s + 2), s/(s^2 + 3\*s + 2)]    ans =  [ 2\*exp(-t) - exp(-2\*t), exp(-t) - exp(-2\*t)]  [ 2\*exp(-2\*t) - 2\*exp(-t), 2\*exp(-2\*t) - exp(-t)] |

**Q4.**

**Description**

If the system is completely state controllable, the rank of Controllability Matrix U must be n.

If the system is completely observable, the rank of Observability Matrix V must be n

Use matlab to find the rank of the matrices.

rank function to find the rank of a matrix.

|  |
| --- |
| A = [ 0 1 0; 0 0 1; -6 -11 -6 ];  B = [ 0; 0; 1 ];  C = [ 20 9 1 ];    U = [ B, A\*B, A^2\*B ]  V = [ C; C\*A; C\*A^2 ]    rank\_U = rank(U)  rank\_V = rank(V) |

|  |
| --- |
| >> hw3  U =  0 0 1  0 1 -6  1 -6 25  V =  20 9 1  -6 9 3  -18 -39 -9  rank\_U =  3  rank\_V =  3 |

Both of rank of U and rank of V are 3. So the system is compeletely state controllable and completely observable.

**Q5.**

**Description**

Used matlab with ss2tf function to calculate transfer function of the system.

|  |
| --- |
| A = [-1 0 1; 1 -2 0; 0 0 -3];  B = [0; 0; 1];  C = [1 1 0];  D = [0];  [num, den] = ss2tf(A, B, C, D) |

|  |
| --- |
| >> hw3  num =  0 0 1 3  den =  1 6 11 6 |

Then controllable canonical form is the following. (by p24@Lecture5)

Then observable canonical form is the following. (by p31@Lecture5)

**Q6.**

**Description**

The characteristic equation after state-feedback controlled is

To get the closed-loop poles at and , the desired charecteristic function is

I used matlab to find the determinant of that matrix.

|  |
| --- |
| syms s k1 k2 k3;  A = [ s, -1, 0;  k1, s+k2, k3-1;  k1+1, k2+5, s+k3+6]  B = det(A) |

|  |
| --- |
| B =  7\*k1 - k3 + 5\*s + k1\*s + 7\*k2\*s - 5\*k3\*s + k2\*s^2 + k3\*s^2 + 6\*s^2 + s^3 + 1 |

So we can get

Solve the equations using matlab

|  |
| --- |
| [0 1 1; 1 7 -5; 7 0 -1]\[8;55;199] |

|  |
| --- |
| ans =  28.7831  5.5181  2.4819 |

So desired matrix K is

**Q7.**

**Description**

use place function to find the gain matrix K

|  |
| --- |
| A = [ 0 1 0; 0 0 1; -1 -5 -6];  B = [ 0; 1; 1];  p = [ -2+4j, -2-4j, -10];  K = place(A, B, p) |

|  |
| --- |
| K =  28.7831 5.5181 2.4819 |

desired matrix K is