Max. marks: 100

1. Answer the following:
    (a) Represent a matrix as a sum of symmetric and skew-symmetric matrices. Given an example.
    (b) Does a singular matrix have eigen values and eigen vectors.
    (c) Define sub-spaces and rank of a matrix.
    (d) What is Markov's Decision process (MDP)? Explain with an example.
    (e) What is the difference between AI, Machine Learning and Deep Learning?

    $(5\times5 = 25)$

2. Decide whether the vectors in each sub-set of $\Re^3$ are linearly dependent or independent. Justify answers.

(a) $\begin{bmatrix} 1 \\ -3 \\ 5 \end{bmatrix}, \begin{bmatrix} 2 \\ 2 \\ 4 \end{bmatrix}, \begin{bmatrix} 4 \\ -4 \\ 14 \end{bmatrix}$; (b) $\begin{bmatrix} 1 \\ 7 \\ 7 \end{bmatrix}, \begin{bmatrix} 2 \\ 7 \\ 7 \end{bmatrix}, \begin{bmatrix} 3 \\ 7 \\ 7 \end{bmatrix}$; (c) $\begin{bmatrix} 9 \\ 9 \\ 0 \end{bmatrix}, \begin{bmatrix} 2 \\ 0 \\ 1 \end{bmatrix}, \begin{bmatrix} 3 \\ 5 \\ -4 \end{bmatrix}, \begin{bmatrix} 12 \\ 12 \\ 1 \end{bmatrix}$ $(3\times5 = 15)$

3. Using SVD decomposition of the following matrix, find its pseudo-inverse:

$$\mathbf{A} = \begin{bmatrix} -1 & 1 & 0 \\ 0 & -1 & 1 \end{bmatrix}$$ (15)

4. (a) Find out the equations of motion of a prismatic and revolute jointed (PR) manipulator using the DeNOC matrices.
    (b) Explain the terms Policy, Reward, State value function, Action value function, and Policy gradient with respect to the control of above PR manipulator

    $(2\times7.5=15)$

5. Using Adams-Bashforth formula, find y (t=0.4) for the following differential equation:
    $y' = 1 - t + 4y$ with y (0) = 1 and step size $h = 0.1$ (10)

6. (a) Define Euler-angles to represent a rotation matrix. State at least two drawbacks of rotation representation using Euler-angles.
    (b) Using DH parameters find out the final homogeneous transformation matrix of the end-effector for the prismatic-revolute manipulator of Question 4(a).

    $(2\times5 = 10)$

7. (a) Explain commonly used Artificial Neural Network. (b) What are the major differences between Stiffness control, Impedence control, Admittance control, and hybrid control?

    $(2\times5 = 10)$

….. END …..

3D (Three days) Written Comprehensive Examination of
Mr. Deepak Raina (2019MEZ8497)
Submission: April 12, 2021, 3pm

Max. marks: 100

1. Write your own program to solve Question 5 of your 3H Written Comprehensive Examination (WCE). Verify the results using ode45 function of MATLAB.

(25)

2. For Question 4(a) of your 3H WCE find its inverse dynamics results for some input trajectory using RoboAnalyzer software. Verify the results using ReDySim software.

(50)

3. Illustrate the five terms in Question 4(b) of 3H WCE using a numerical example of the RP manipulator. (25)

Submit a hand-written report with relevant algorithms, and printout of the plots and programs.