Written Comprehensive (Closed-book) Examination for

Mr. Sreejath.S. (2017MEZ8321)

November 26, 2018 (Monday), 15-18 hrs

Duration: 3 hours **Marks: 100**

[Write answers in two different answer books]

By S.K. Saha

1. Answer the following:

(a) Decide whether the vectors below in $\Re^3$ are linearly dependent or independent. Justify answers.

$$\begin{bmatrix} 1 \\ -3 \\ 5 \end{bmatrix}, \begin{bmatrix} 2 \\ 2 \\ 4 \end{bmatrix}, \begin{bmatrix} 4 \\ -4 \\ 14 \end{bmatrix}$$

(b) Find $\mathbf{LL}^T$ (Cholesky) decomposition of the following matrix:

$$\mathbf{A} = \begin{bmatrix} 9 & -1 & 2 \\ -1 & 8 & 5 \\ 2 & 5 & 7 \end{bmatrix}$$

(c) Find the solution of 2nd order differential equation numerically for the value of $x = 1$.

$y'' - 3y' + 2y = 0$ with initial conditions $y(0) = 4, y'(0) = 5$

[3 x 5 = 15]

2. (a) Using sketches, define holonomic and non-holonomic constraints of a mechanical system.

(b) Find out the equations of motion of a prismatic and revolute jointed manipulator using the DeNOC matrices.

[5+10=15]

3. (a) Given a set of points to be spline fitted. How do you model it? Formulate the problem and illustrate with a numerical example where the three points are to be interpolated using the spline curves.

(b) Using ZXY Euler Angles find out the orientation matrix. Write the angles for which its inverse calculations are not possible.

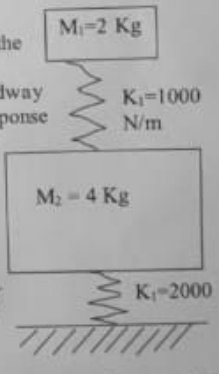
[10+10 = 20]

By S.P. Singh

1. (a) For the 2-DOF system shown find the natural frequencies and the normal modes. Set up the modal equations of motion.

(b) If the mass M_1 is given a harmonic excitation at a frequency midway between the two frequencies. Find using modal analysis the response amplitudes at both the masses.

[10+10=20]



2. A rotor machine of mass 650 kg. Operating at a constant speed of 1500 rpm has an unbalance of 0.12 kg. If the damping in the isolators is given by damping ratio of ξ=0.08, determine the stiffness of the isolators so that the transmissibility at the operating speed is less than or equal to 0.15. Also determine the magnitude of the force transmitted.

[10]

3. Explain the basic axioms of Cosserat rod theory. Show how you specify the boundary conditions and constitutive equations in this theory? Explain the application for a cantilever beam. [10]

4. What is the meaning of consistent mass matrix. Explain with reference to a beam element the difference between lumped mass element vs consistent mass element. [10]

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Take-home Comprehensive Examination

Mr. Sreejath.S. (2017MEZ8321)

November 26 (Monday, 6pm) -28 (Wednesday, 10am), 2018

Submission: November 28, 2018 (Wednesday), 10am **Marks: 100**

1. Formulate a static loading of a Cantilever beam as a finite-element problem. Write a MATLAB program to find its deflection at the tip for different length and loads. Verify the results using analytical formulas available in any text book on Design or Strength of Materials. [40]

2. Implement the algorithms of SVD decomposition and Trapezoidal rule to solve the problems in 1(b) and 1 (c) in written comprehensive examination. Verify the results obtained during your written examination and the in-built functions of MATLAB, if available. [40]

3. Find the time response of Question1 (by S.P. Singh) using an ODE solver of MATLAB. Compare the results with those obtained during the written examination. [20]

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

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