Code No: **RT41211** **R13** **Set No. 1**

IV B.Tech I Semester Supplementary Examinations, February - 2019

VIBRATIONS AND STRUCTURAL DYNAMICS

(Aeronautical Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) What are the common types of damping and define damping constant? [3]
   b) What is the torsional stiffness of a solid aluminum shaft ($G=40 \times 10^9$ N/m^2) with a length of 1.8 m and a radius of 25 cm? [4]
   c) What is the vibration amplitude of the primary system when a dynamic vibration absorber tuned to the excitation frequency is added to the system? [4]
   d) What is the modal damping ratio? [3]
   e) What is a rotation matrix? What is its purpose in Jacobi s method? [4]
   f) How can we generate the frequency transfer function from the general transfer function? [4]

PART–B *(3x16 = 48 Marks)*

2. a) State three different ways of expressing a periodic function in terms of its harmonics, and define the terms: cycle, amplitude, phase angle, linear frequency, period, and natural frequency. [8]
   b) Find the spring constant of the bimetallic bar shown in figure. 2(b) in axial motion.

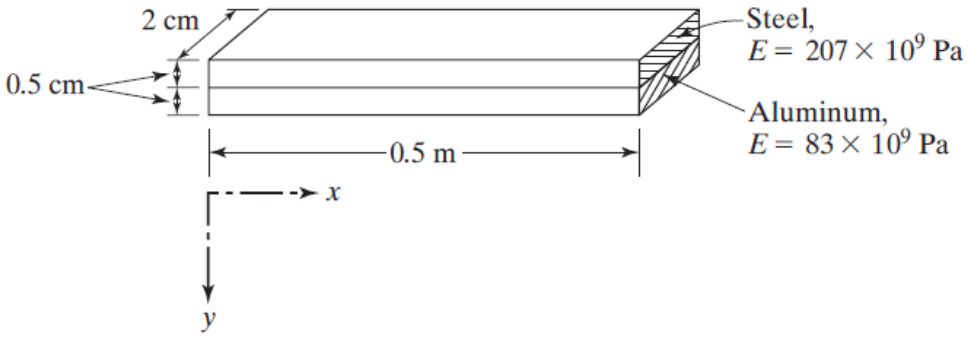

Figure. 2(b) [8]

3. a) A spring mass system has a natural frequency of 12 Hz. When the spring constant is reduced by 800 N/m, the frequency is changed by 50%. Determine the mass and spring constant of the original system. [8]
   b) An automobile having a mass of 2,000 kg deflects its suspension springs 0.02 m under static conditions. Determine the natural frequency of the automobile in the vertical direction by assuming damping to be negligible. [8]

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4. a) Determine the natural frequencies for the two degree-of-freedom system shown in figure. 4(a).

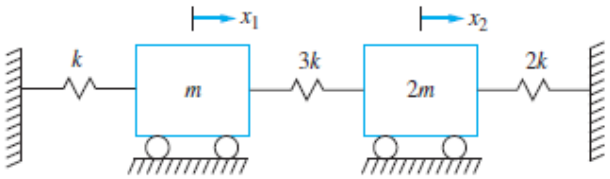

Figure. 4(a) [8]

b) Use the free-body diagram method to derive the differential equations governing the motion of the systems shown in figures 4(b) using the indicated generalized coordinates.

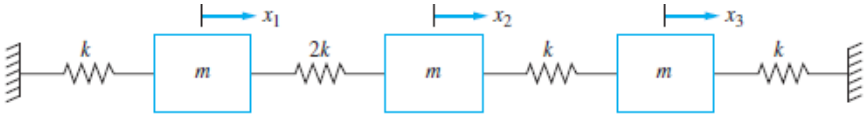

Figure. 4(b) [8]

5. a) Prove that Rayleigh s quotient is never higher than the highest eigen value. [8]

b) The stiffness and mass matrices of a vibrating system are given by

$$[k] = k\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 3 \end{bmatrix}, \quad [m] = m\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix}$$

Using Holzer s method, determine all the principal modes. [8]

6. a) The mass and stiffness matrices of a spring-mass system are known to be

$$[m] = m\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 2 \end{bmatrix} \quad \text{and} \quad [k] = k\begin{bmatrix} 2 & -1 & 0 \\ -1 & 3 & -2 \\ 0 & -2 & 2 \end{bmatrix}$$

Using the matrix iteration method, find the natural frequencies and mode shapes of the system. [8]

b) Using Jacobi s method, find the eigenvalues and eigenvectors of the matrix

$$[D] = \begin{bmatrix} 3 & 2 & 1 \\ 2 & 2 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$ [8]

7. a) A spring-mass system is subjected to a harmonic force whose frequency is close to the natural frequency of the system. If the forcing frequency is 39.8 Hz and the natural frequency is 40.0 Hz, determine the period of beating. [8]

b) Consider a spring-mass-damper system with k = 4000 N/m, m = 10 kg, and c = 40 N-s/m. Find the steady-state and total responses of the system under the harmonic force F(t) = 200 cos 10t N and the initial conditions $x_0 = 0.1\ m\ and\ \dot{x}_0 = 0$. [8]