Ref. No.: Ex/ME(M2)/PE/H/T/424A/2023

B.E. MECHANICAL ENGINEERING FOURTH YEAR SECOND SEMESTER EXAM 2023

FINITE ELEMENTS FOR DYNAMICS AND NON-LINEARITY(HONS.)

Answer any FIVE questions –

1) For, ANY FOUR, of the following problems, what element and what type of analysis (or analyses) would you recommend. Explain you answer with reasons – (4x5=20)
   (i) Chasis of railway wagon
   (ii) Spur gear
   (iii) Pressure vessel
   (iv) LP stage of steam turbine blade
   (v) Gear box
2) (i)State the assumptions in the theory of thin plate.
   (ii) Deduce the following moment curvature relation for a thin plate.

$$\begin{Bmatrix} M_x \\ M_y \\ M_{xy} \end{Bmatrix} = D \begin{bmatrix} 1 & \mu & 0 \\ \mu & 1 & 0 \\ 0 & 0 & \frac{1-\mu}{2} \end{bmatrix} \begin{Bmatrix} -w_{xx} \\ -w_{yy} \\ 2w_{xy} \end{Bmatrix}$$

   (iii) Write a short note on the different approaches for modelling a thin shell.
   (5+10+5=20)
3) (i) Consider the functional $\int_a^b f(x, y, y', y'')dx$. Deduce the Euler Lagrange differential equations and the possible boundary conditions.
   Write the expression for strain energy of a beam. Using the results of the above problem, obtain the differential equation for a beam. Also obtain the dynamic boundary condition for a simple support.
   (ii) Deduce the expression for strain energy of a plate and cast it in matrix form.
   (10+10=20)
4) (i) Using Q 3(ii), state the nodal variables for a plate element. Explain your answer.
   (ii) Write the displacement function for a 4 noded rectangular plate element. Explain the choice of the various terms.
   (iii) Is the element conforming? Explain your answer.
   (5+5+10=20)
5) (i) For a 1d bar element with 2 nodes, write the displacement function. Thereafter obtain the consistent mass matrix for the element. Also obtain the lumped mass matrix.
   (ii)Classify different types of eigen solvers. Briefly discuss their usage.
   (10+10=20)

6) A simple model of an automobile is shown in Fig 1. It has a mass of 1500 kg. The distance between wheel base is 0.3 m. The distance of the mass centre from the front wheel base is 0.17m. The radius of gyration about CM is 0.1 m. The spring stiffness for the front and rear wheels is 45 N/mm and 40 N/mm respectively. Obtain the natural frequencies and mode shapes.
If you consider the chassis as flexible, will the mode shapes change.
What improved models of the automobile can you suggest.

(20)

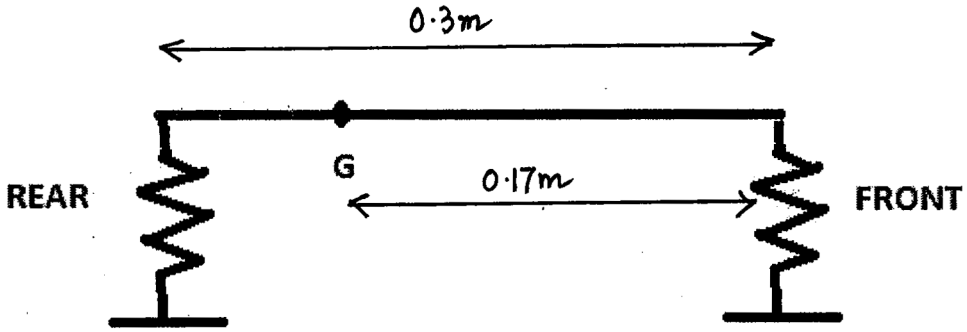

FIG 1

7) Describe the mode superposition method without damping.
Now insert the damping matrix in proper form.
Discuss the advantages of the method.

(20)