1. Find the equivalent stiffness of a spring whose behaviour is equivalent to the system shown in Figure 1 with respect to the displacement .

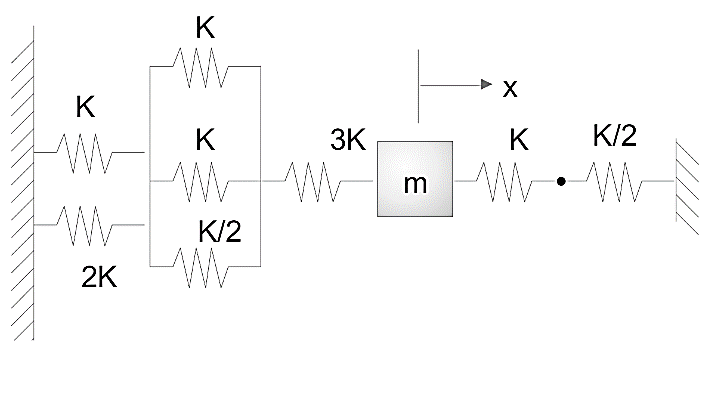


Figure 1

For the network of springs on the left and right of the mass, , respectively, the effective spring constants, and , are

The total strain energy for the system can thus be stated as

So,

2. Determine the equivalent stiffness of the systems shown in Figures 2 and 3 with respect to the displacement .

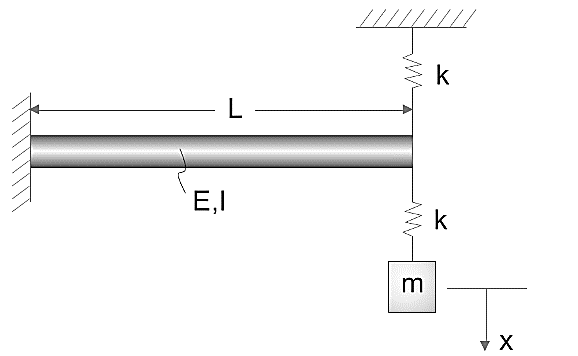


Figure 2

The rod of length , may be assumed to be a cantilever beam with a tip force , and from Solid Mechanics, its deflection at the tip (which is also maximum for this case) may be expressed as,

and analogous to a linear spring, its stiffness can be expressed as,

Thus the two springs with stiffness and the rod can be assumed to be a set of springs in series, and their effective stiffness becomes

Thus,

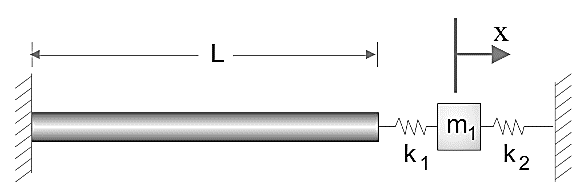


Figure 3

The rod of length , and area , may be assumed to be loaded axially, so from Solid Mechanics, its axial deformation can be expressed as,

and analogous to a linear spring its stiffness can be expressed as,

Since and the rod are in series, their effective stiffness becomes

Then the total strain energy for the system can be stated as

Thus,

3. For the system shown in Figure 4, find the equivalent mass and equivalent stiffness of the rocker arm assembly with respect to the -coordinate.

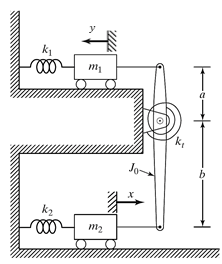


Figure 4

Let the displacement of be denoted as , positive towards the left, as labelled on Figure 4, so that, and .

Thus,

Further, the total strain energy for the system can be stated as

Thus,

Also, the total kinetic energy for the system can be stated as

Thus,

4. For the system shown in Figure 5, find the equivalent mass and equivalent stiffness with respect to the -coordinate.

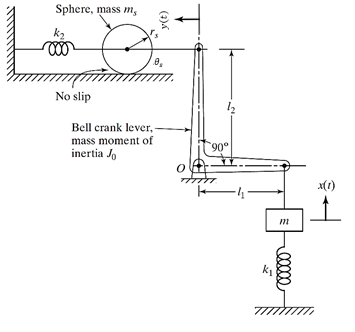


Figure 5

Let the linear horizontal displacement of the bell crank lever be denoted as , positive towards the left, as labelled on Figure 5, so that, and .

Thus,

Further, the total strain energy for the system can be stated as

Thus,

Also, the total kinetic energy for the system can be stated as

Further, for a sphere, from the theory of Engineering Dynamics,

So that,

5. For the system shown in Figure 6, find the equivalent translational damping with respect to .

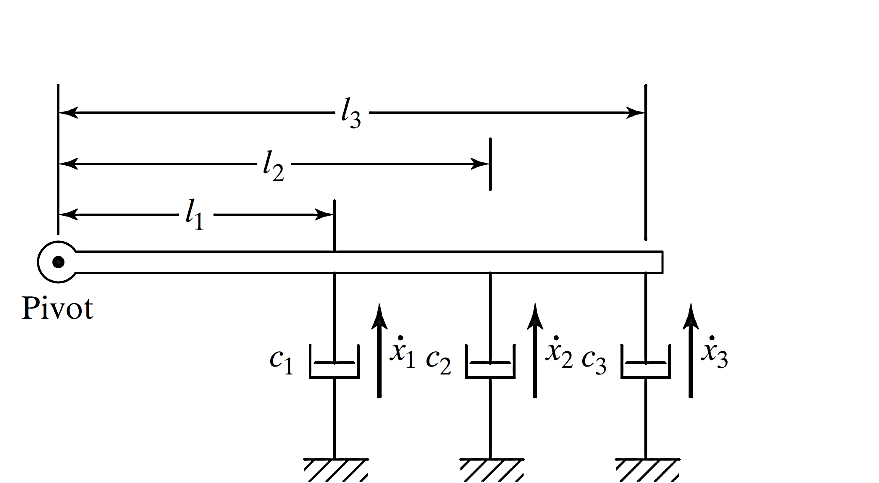


Figure 6

Since , , , therefore,

and thus,

The total work done against the damping force in this system can be written as,

Thus,