INDIAN INSTITUTE OF TECHNOLOGY BOMBAY
DEPARTMENT OF CIVIL ENGINEERING
CE 102 ENGINEERING MECHANICS: FINAL EXAMINATION

Date: 26-04-2018 Maximum Marks: 50
Time: 5:30 pm – 8:30 pm

Read the questions carefully. Show the steps clearly and mark the final answers. Start new question on a fresh page. Draw clear FBDs. Assume suitable additional data, if required and state the same clearly.

1. Find the force in members ***JQ***, ***XQ*** and ***XJ*** for the Baltimore truss shown in **Figure 1** where all angles are 30°, 60°, 90° or 120°. Clearly state if the members are in tension or compression. **(9 marks)**

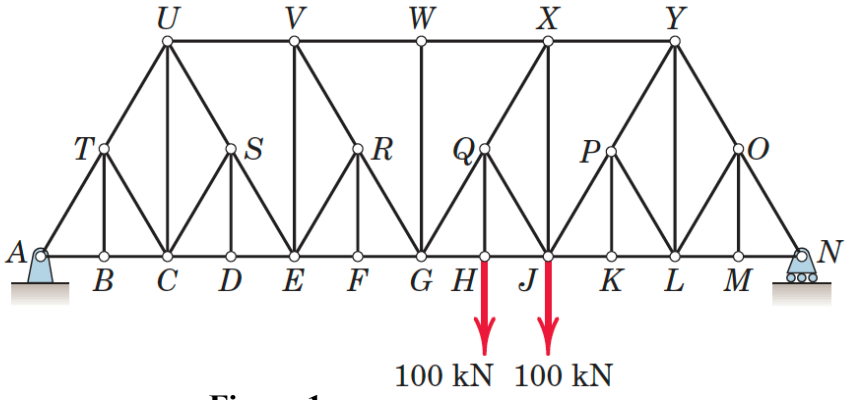

Figure 1

2. If ***P*** **= 75 N**, determine the force ***F*** that the toggle clamp exerts on the wooden block as shown in **Figure 2**. Solve using principle of **virtual work** only. Neglect any friction effects. **(9 marks)**

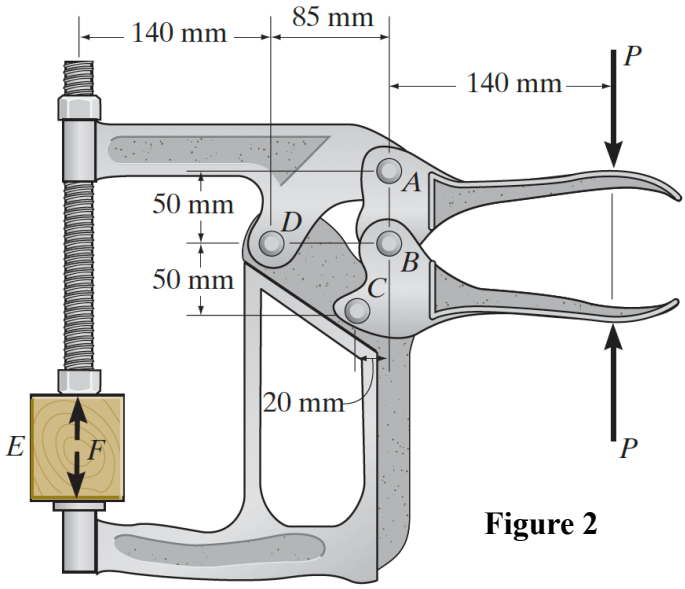

Figure 2

3. A clockwise couple ***M*** is applied to the circular cylinder as shown in **Figure 3**. Determine the value of ***M*** required to initiate motion for the conditions m_B **= 3 kg**, m_C **= 6 kg**, $(\mu_s)_B$ **= 0.5**, $(\mu_s)_C$ **= 0.4** and ***r*** **= 0.2 m**. Friction between the cylinder ***C*** and block ***B*** is negligible. Use acceleration due to gravity **g = 10 m/s²**. **(8 marks)**

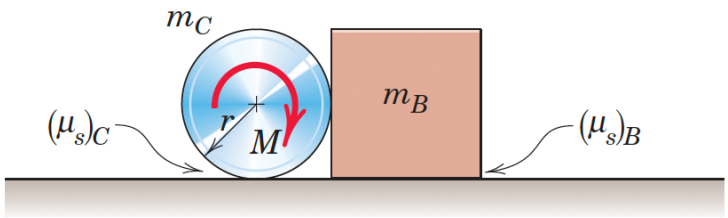

Figure 3

4. As shown in **Figure 4** two rectangular plates are welded together to form the assembly shown. The assembly is supported by **ball-and-socket** joints at ***B*** and ***D***, and by a **ball** on a horizontal surface at ***C*** that can exert only a **vertical reaction**. For the loading shown, determine the **reaction** at ***C***. **(8 marks)**

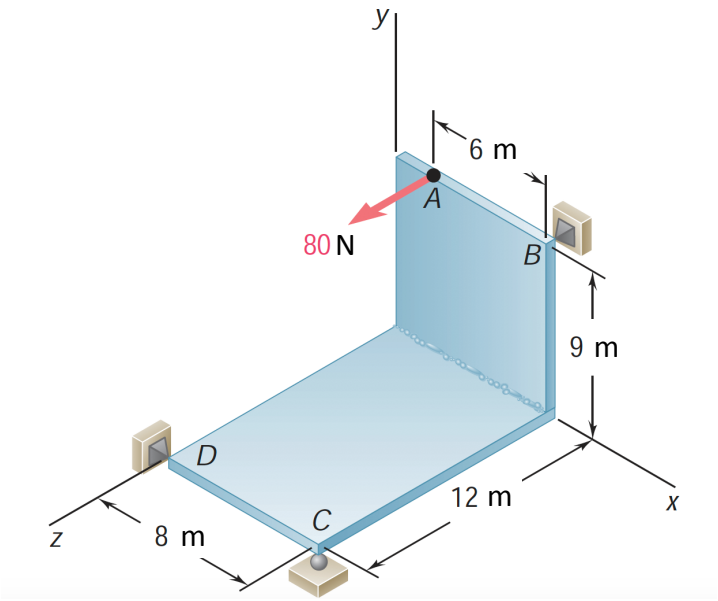

Figure 4

5. Members ***ACE*** and ***BCD*** are connected at ***C*** by a pin, as shown in **Figure 5**. Find the supporting forces at ***A*** and ***B***. Note that the circular cylinder attached at ***D*** weighs **300 N** and has **radius** of **1 m**. Neglect any friction effects. **(8 marks)**

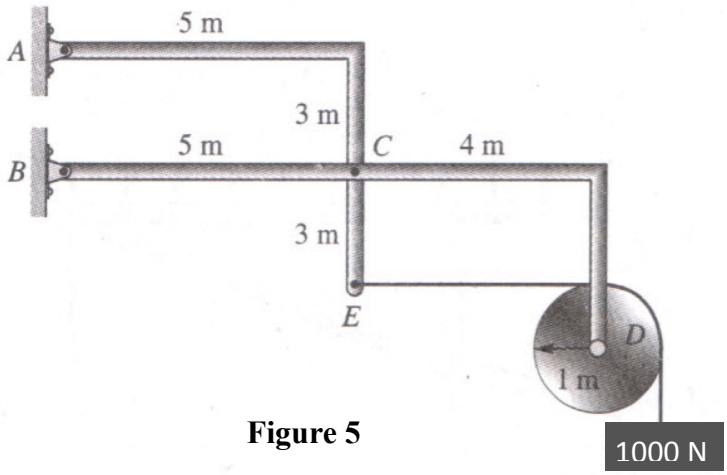

Figure 5

6. Find the natural frequency in **Hz** of the system shown in **Figure 6**. Take ***total mass*** of the uniform bar ***ABCD***, **m = 200 kg**, spring constant ***k* = 25 N/mm**, and ***L* = 2 m**. Neglect Gravity. **(8 marks)**

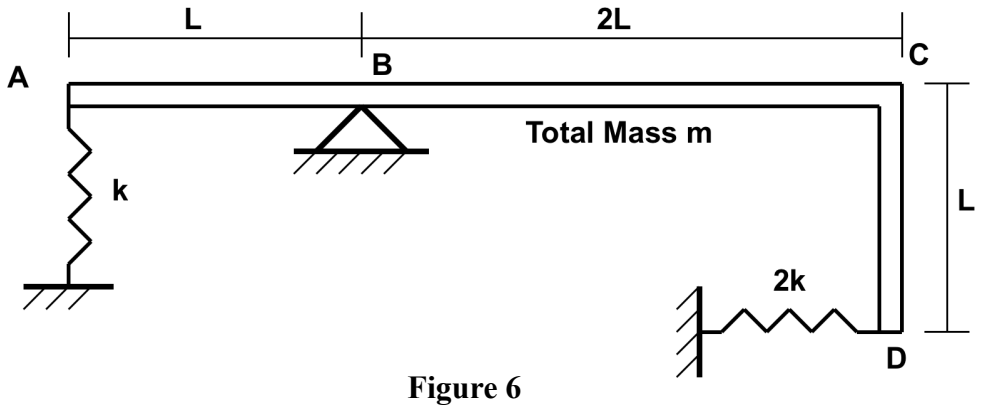

Figure 6