**Name:**

**Enrolment No:**

**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**

**End Semester Examination, May 2022**

**Course: Mechanical Vibration** | **Semester: VI**

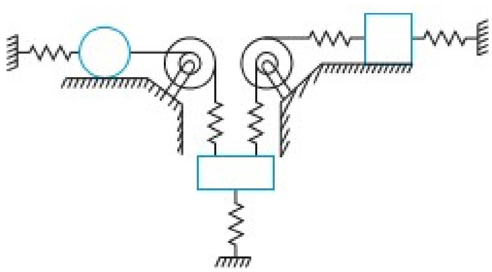
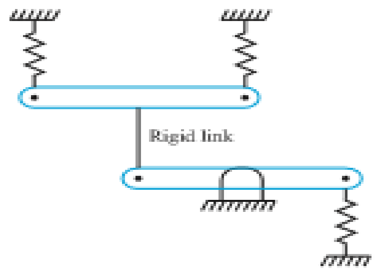
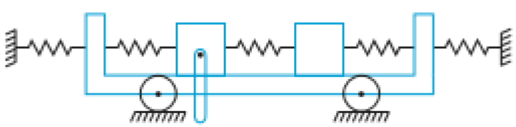
**Program: B.Tech Mechanical** | **Time : 03 hrs.**

**Course Code: MECH 4009** | **Max. Marks: 100**

**Instructions: Attempt all the questions. Assume suitable data if missing.**

**SECTION A**

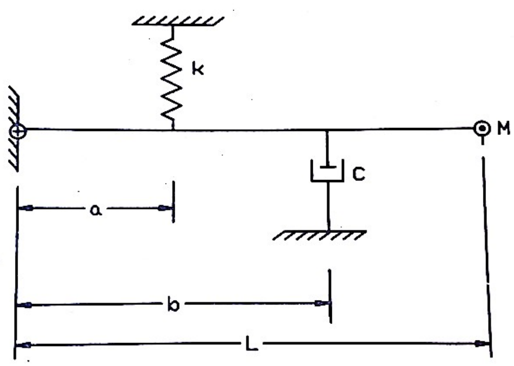
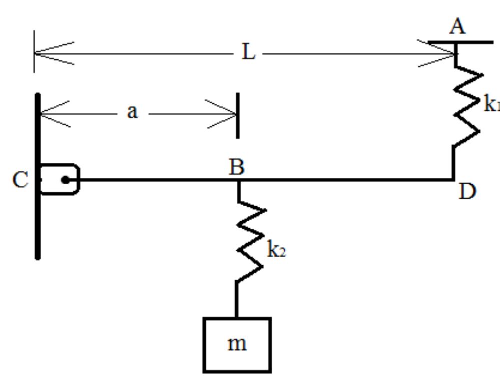
**(5Qx4M=20Marks)**

| | | Marks | CO |
|---|---|---|---|
| Q 1 | Enumerate the degree of freedom required to model the system shown in figures shown below.     | **4** | **CO1** |
| Q 2 | Define the synchronous whirl. Also, discuss the causes of whirling of a shaft. | **4** | **CO1** |
| Q 3 | Justify the statement "Vibration analysis of a non-linear system involves much complexities" | **4** | **CO2** |
| Q 4 | The one-dimensional displacement of a particle is<br>$x(t)=¿$ m,<br>Find *maximum* displacement, velocity and acceleration of the particle | **4** | **CO1** |
| Q 5 | Define the term Eigen value and Eigen vector. | **4** | **CO1** |

**SECTION B**

**(4Qx10M= 40 Marks)**

| | | | |
|---|---|---|---|
| Q 6 | A rotor having a mass of 5 kg is mounted midway on a 1 cm diameter shaft supported at the ends by two bearings. The bearing span is 40 cm. Because of certain manufacturing inaccuracies, the c.g. of the disc is 0.02 mm away from the geometric centre of the rotor. If the system rotates at 3000 rpm, Find the amplitude of the steady state vibration and force transmitted to the bearings. Neglect | **10** | **CO3** |

| | | | |
|---|---|---|---|
| | damping and take E = 1.96 x $10^{11}$ N/$m^2$. | | |
| Q 7 | Derive an expression for wave equation for longitudinal vibrations of bars. Also, find the solution of the equation. | **10** | **CO2** |
| Q 8 | A viscously damped system has a stiffness of 5000 N/m, critical damping constant of 0.2 N-s/mm, and a logarithmic decrement of 2. If the system is given an initial velocity of 1 m/s, determine the maximum displacement of the system.<br>For a spring mass damper system, $m$ = 50 kg and $k$ = 5000 N/m. Find the following (i) critical damping constant $c_c$, (ii) damped natural frequency when $c = c_c/2$ (iii) logarithmic decrement. | **10** | **CO4** |
| Q 9 | Write the differential equation of motion for the system shown in figure below and find the natural frequency of damped vibration and damping ratio for the system.<br><br>OR<br>Derive the expression of natural frequency for the system shown in. Assume the bar CD to be weightless and rigid.<br> | | **CO2** |
| **SECTION-C**<br>**(2Qx20M=40 Marks)** | | | |
| Q 10 | Perform the modal analysis of the system shown in Fig. Take $m_1$ = 10 kg, $m_2$ = 1 | **20** | **CO3** |

<table>
<tr>
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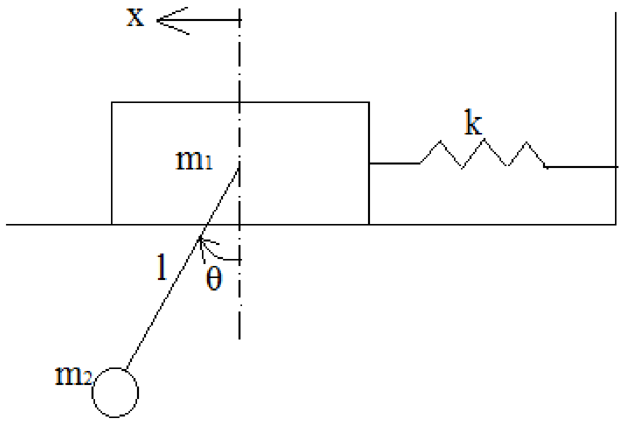
<td>kg, r = 0.1 m, length of string of pendulum, $l$ = 1 m and k = 10000 N/m. Take g = 10 m/s$^2$.




OR

In a refrigeration plant, a section of pipe carrying the refrigerant vibrated violently at a compressor speed of 240 rpm. To eliminate this difficulty, it was proposed to clamp a cantilever spring mass system to the pipe to act as an absorber. For a trail test, a 900 gm absorber tuned to 240 rpm, resulted in two natural frequencies of 198 and 272 cpm. If the absorber system is to be designed so that the natural frequencies lie outside the region 160 and 360 cpm. Calculate the weight and spring stiffness.</td>
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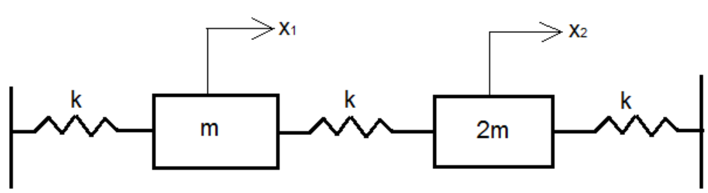
<td>Find the natural frequencies and amplitude ratios of the system shown in figure below.




OR

A double pendulum of lengths $L_1$ and $L_2$, masses $m_1$ and $m_2$ is shown in figure. If $m_1$=$m_2$=5 kg and $L_1$ = $L_2$=25 cm, find the natural frequencies.</td>
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<td>CO4</td>
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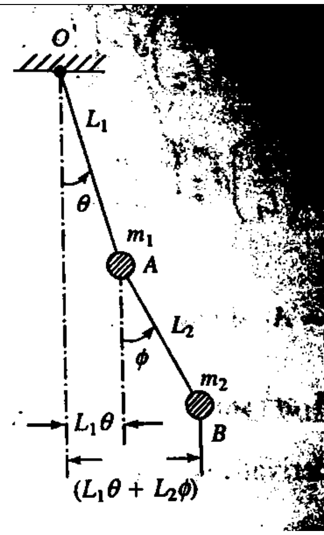
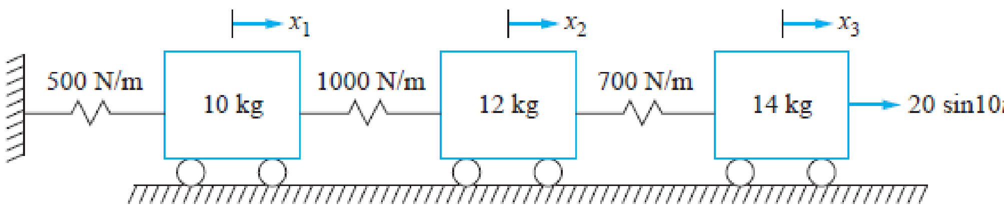
<tr><td></td><td>
</td><td></td><td></td></tr>
<tr><td>Q 11</td><td>Determine the forced response of the three degree-of-freedom system shown in Figure.<br>
</td><td>20</td><td>CO3</td></tr>
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