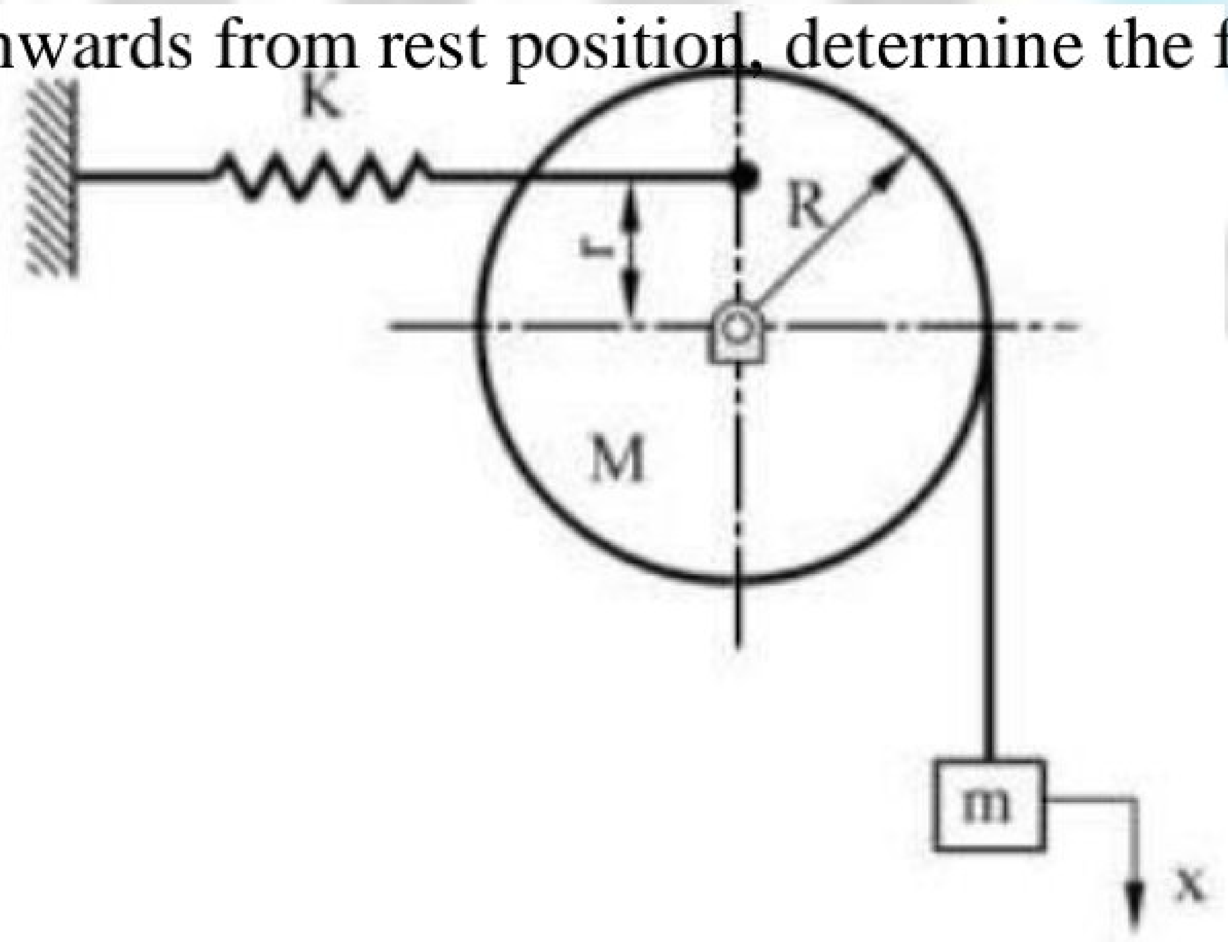
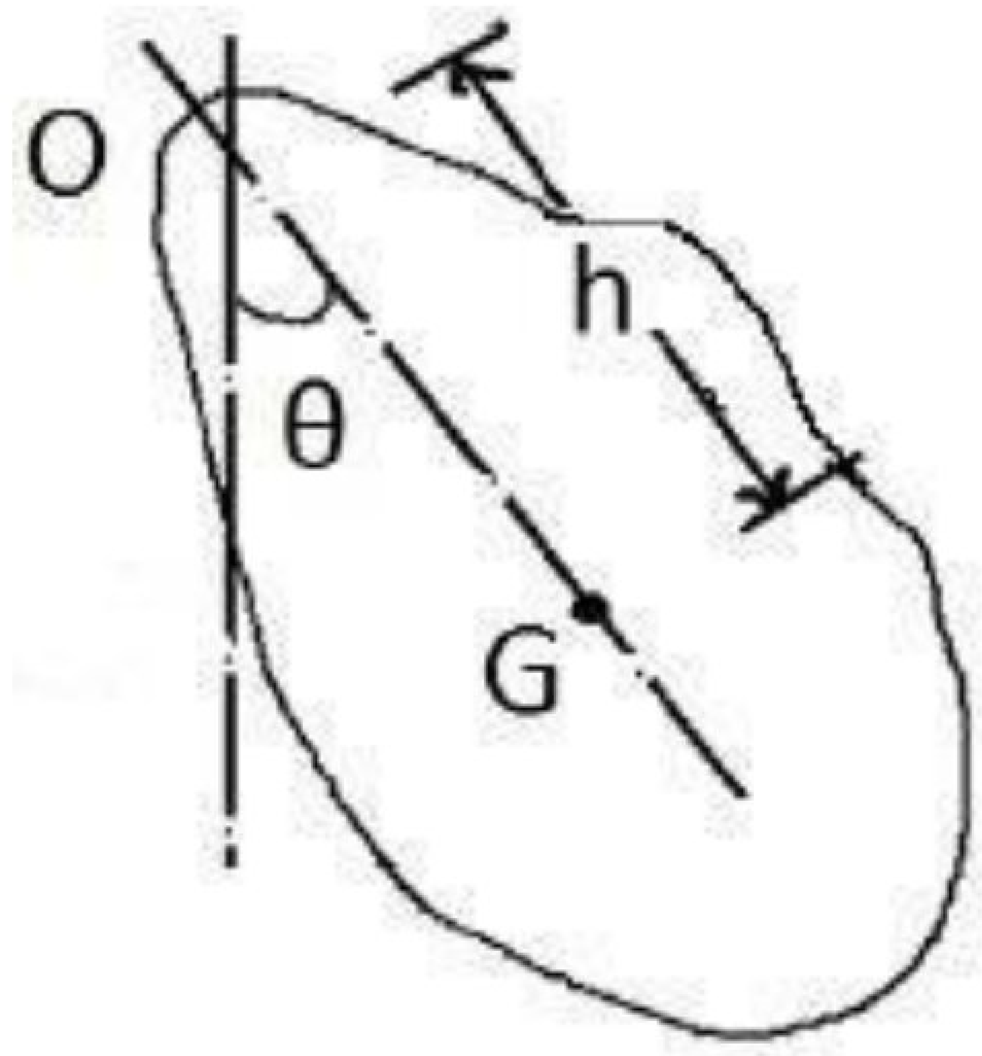
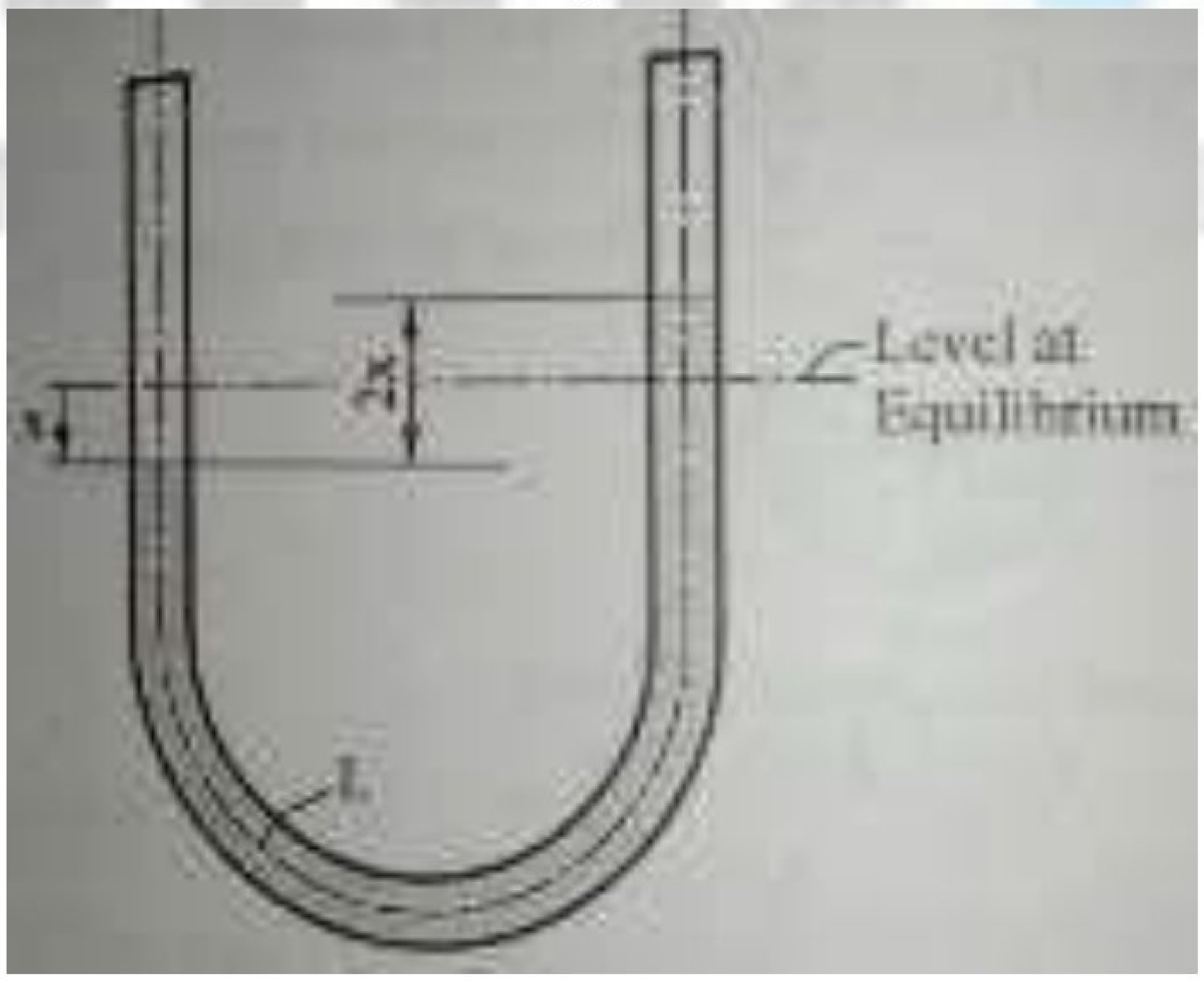
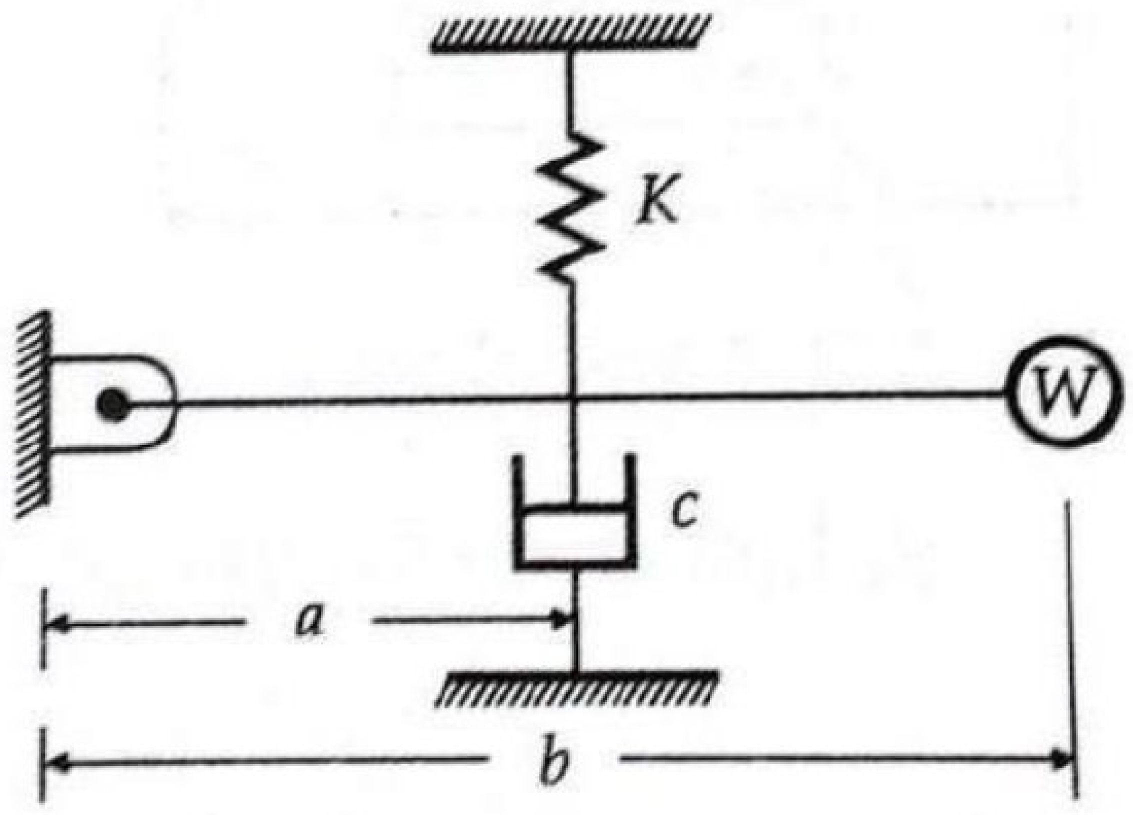
# ASSIGNMENT NO 5 : Single Degree of Freedom System (Linear and Torsional)

| | |
|---|---|
| 1. | **Define**: "Resonance & Damping", "Undammed Free Vibration", "Critical Damping Coefficient" ($C_C$), "Forced Vibrations", 'Force Transmissibility' ($T_r$) |
| 2. | Explain **Equilibrium method** to find the frequency of vibratory system. |
| 3. | The mass 'm' is hanging from a chord attached to the circular homogeneous disc of mass 'M' and radius 'R' as shown in Figure. The disc is restrained from rotating by a spring attached at radius 'r' from the centre. If the mass is displaced downwards from rest position, determine the frequency of oscillations.  |
| 4. | What is meant by **vibration isolation and transmissibility**? |
| 5. | Discuss the vibration response of a single degree of freedom system if the damping provided is **under damped system.** |
| 6. | **Define**: Resonance, logarithmic decrement and magnification factor. |
| 7. | Find the **equation for natural frequency** of a spring mass vibrating system by using **Equilibrium method and Rayleigh's method.** |

| | |
|---|---|
| 8. | Determine equation for the **natural frequency of vibration of the compound pendulum** shown in figure.  |
| 9. | What is **vibration isolation**? What are its objectives & its materials? |
| 10. | What is **transmissibility**? Plot the transmissibility and frequency curve for different damping conditions. |
| 11. | What is the importance of forced **transmissibility** in mechanical vibrations? |
| 12. | A U tube, open to atmosphere at both ends contains a column length L of a certain liquid as shown in figure. Find the **natural period of oscillation of the liquid column**.  |

# Examples

| | |
|---|---|
| 1. | A coil of spring stiffness 4 N/mm supports vertically a mass of 20 kg at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Determine the damping force per unit velocity. Also find the ratio of the frequency of damped and undamped vibrations. |
| 2. | A single cylinder engine has a mass of 100 kg and is acted upon by a vertical unbalanced force of 400 sin ($13\pi t$) N. The engine block is supported on a spring having a stiffness 60 kN/m and a damper which gives a damping force of 700 N per unit velocity. Find the damping ratio and force transmitted to the foundation. |
| 3. | A refrigerator unit having mass of 35 kg is to be supported on three springs, each having a spring stiffness s. The unit operates at 480 rpm. Find the value of stiffness s if only 10% of the shaking force is allowed to be transmitted to the supported. |
| 4. | A vertical spring mass system has a mass of 0.5 kg and an initial deflection of 0.2 cm. find the spring stiffness and the natural frequency of the system. |
| 5. | A vibrating system is defined by the following parameters: m=3 kg, k=100 N/m, C=3 N-sec/m. Determine (a) the damping factor (b) the natural frequency of damped vibration (c) logarithmic decrement (d) the ratio of two consecutive amplitudes (e) the number of cycles after which the original amplitude is reduced to 20 percent. |
| 6. | Derive equation of motion for the system shown in Figure. If m = 1.5 kg, k = 4900 N/m, a = 6 cm and b = 14 cm, determine the value of damping coefficient (C) for which the system is critically damped.   |

| | |
|---|---|
| 7. | A pump is supported on a spring and a damper. The spring stiffness is 6000N/m and the damper offers resistance of 480 N at 3.5 m/s. The unbalanced mass of 0.6 kg rotates at 40 mm radius and total mass of the system is 80 Kg. The pump is running at 500 rpm. Determine: i) damping factor, ii) amplitude of vibration iii) resonant speed and amplitude at resonance. |
| 8. | Governing equation of motion of an underdamped single degree of freedom system with a mass of 31 kg is given as $d^2x/dt^2 + (3c/7m)\, dx/dt + (27k/7m)\, x = 0$. The amplitude of damped vibration reduces from 3 mm to 2 mm in successive vibrations in a duration of 0.1 seconds. Evaluate: i) frequency of damped vibration, ii) logarithmic decrement, iii) damping factor, iv) natural frequency, v) stiffness and vi) damping coefficient. |
| 9. | A machine having mass of 100 kg is supported on a spring which deflects 20 mm under the dead load of machine. A dashpot is fitted to reduce the amplitude of free vibration to 10% of its initial value in two complete oscillations. Determine the stiffness of the spring, critical damping coefficient, logarithmic decrement, damping factor and frequency of damped-free vibration. |
| 10. | The electric motor is supported on a spring and a dashpot. The spring has the stiffness 6400 N/m and the dashpot offers resistance of 500 N at 4 m/sec. The unbalanced mass 0.5 kg rotates at 50 mm radius and the total mass of vibratory system is 20 kg. The motor runs at 400 RPM. Determine (a) Damping factor (b) Amplitude of vibration and phase angle (c) Resonant speed and amplitude. |