**Name:**

**Enrolment No:**

# UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

## End Semester Examination, December 2019

**Program Name: B-Tech Mechatronics** **Semester: VII**
**Course Name: Mechanical Vibrations** **Time: 03 hrs**
**Course Code: MHEG483** **Max. Marks: 100**
**Nos. of page(s):**

**Instructions: If data is insufficient, make relevant assumptions and state the same.**

### SECTION A (Marks-30)

| Sl. No. | | Marks | CO |
|---|---|---|---|
| Q 1 | a) What will be the change in natural frequency of simple pendulum if its length is halved?<br>b) State the most important reason for whirling of shafts to occur.<br>c) The mass matrix of multibody freedom system is always symmetric. State True/False<br>d) Both mass and damping coupling are known as ---<br>e) In a system with rotational imbalance the effect of damping becomes negligibly small at higher speeds. State True/False | **5x1 =5** | **CO1**<br>**CO1**<br>**CO1**<br>**CO1**<br>**CO1** |
| Q 2 | a) A mass of 10 kg is supported on a spring having a stiffness of 980 N/m and a mass of 5 kg. The damping coefficient is 8 N s/m. Determine the natural frequency of system. Find also the logarithmic decrement and the amplitude after 3 cycles.<br>b) Explain the difference between Dunkerley's method and Stodola method for determining the natural frequencies of a multi body sytem.<br>c) A rotor having a mass of 10 kg is mounted midway on a 0.01m dia shaft supported at the ends by two bearings. The bearing span is 0.5m. Because of certain manufacturing inaccuracies the CG of disc is 0.03 mm away from its geometric cener of rotor. If the system rotates at 3000 rpm find the amplitude of steady state vibrations and the dynamic force transmitted to the bearings. E=200 GPa<br>d) What is meant by static and dynamic coupling? How can you eliminate coupling of the equations of motion?<br>e) Develop a suitable mathematical model for the given system. (Draw the model. No need to derive the EOM) | **5x5=25** | **CO2**<br>**CO1**<br>**CO3**<br>**CO1**<br>**CO2**<br>**CO3** |

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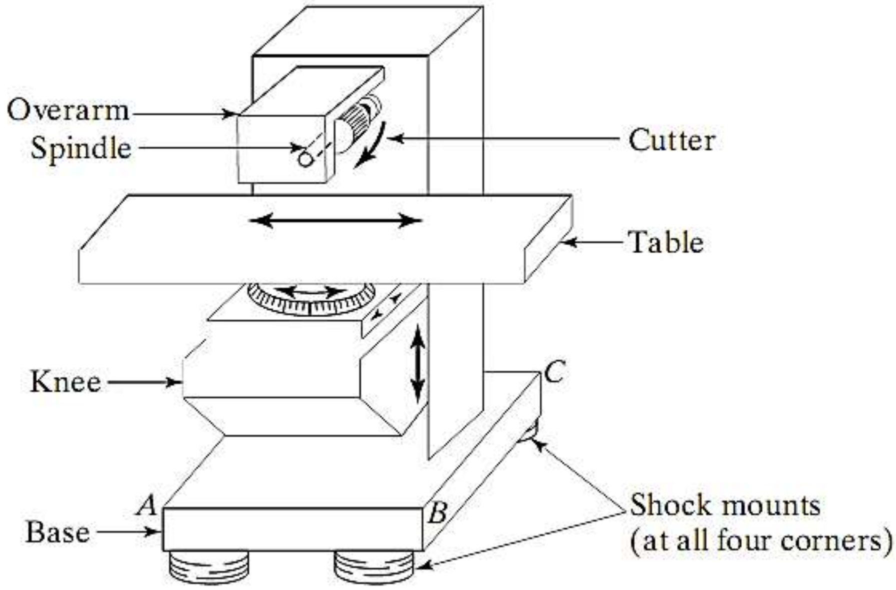
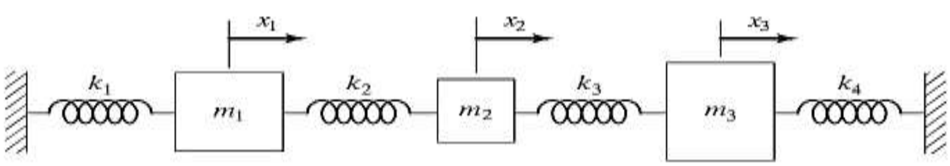
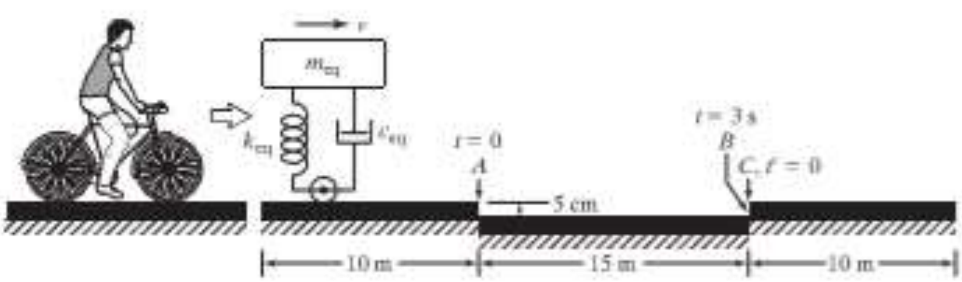
| |   | | |
| | **SECTION B (Marks-30)** | | |
| Q3 | The damped natural frequency of a system as obtained from a free vibration test is 9.8 Hz. During the forced vibration test with constant exciting force on the same system, the maximum amplitude of vibration is found to be at 9.6 Hz. Find the damping factor of the system and its natural frequency. | **10** | **CO3** |
| Q4 | Derive the equation of motion (EOM) of the system given below.<br>  | **10** | **CO2**<br>**CO3** |
| Q5 | A boy riding a bicycle can be modeled as a spring-mass-damper system with an equivalent weight, stiffness, and damping constant of 900 N, 55,000 N/m, and 1,500 N-s/m, respectively. The differential setting of the concrete blocks on the road caused the level surface to decrease suddenly, as indicated in Fig. If the speed of the bicycle is 20 km/hr, determine the displacement of the boy in the vertical direction. Assume that the bicycle is free of vertical vibration before encountering the step change in the vertical displacement.<br>  | **10** | **CO4**<br>**CO3** |

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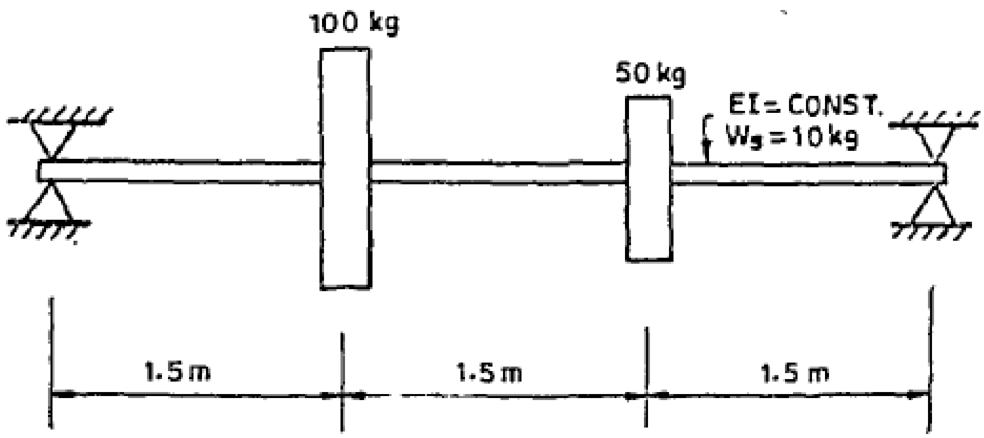
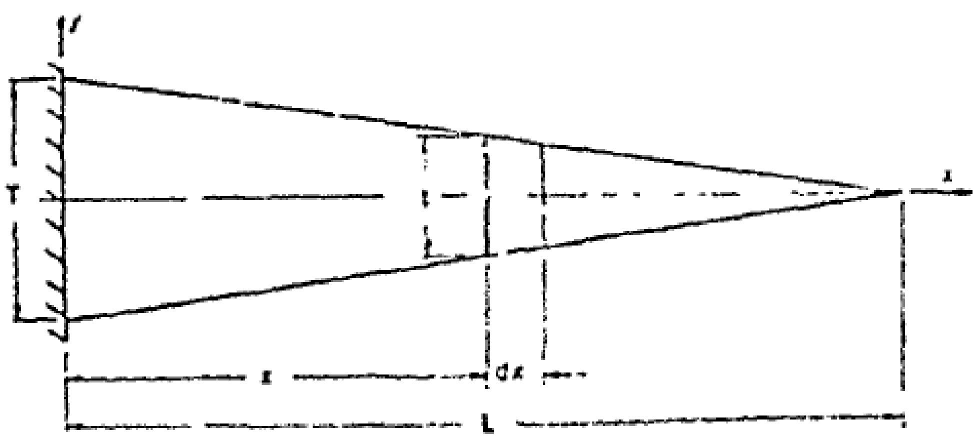
| | OR | | |
| Q5 | A compound pendulum with mass of rod Mr and mass of bob Mb is oscillating freely on its hinge. If the length of pendulum is L find its frequency of oscillation. | **10** | **CO4**<br>**CO3** |
| | **SECTION-C (Marks 40)** | | |
| Q6 | Using Dunkerley's method find the fundamental natural frequency of the following system.<br><br> | **20** | **CO2** |
| Q7 | Find the natural frequency of the vibration of a tapered bar fixed at its base using Rayleigh-Ritz method as shown in figure. Take the width of the bar as unity.<br><br> | **20** | **CO2**<br>**CO4** |
| | OR | | |
| Q7 | An automobile is modeled with a capability of pitch and bounce motions, as shown in Fig. It travels on a rough road whose surface varies sinusoidally with an amplitude of 0.035 m and a wavelength of 7.5 m. Derive the equations of motion of the automobile for the following data:<br>Radius of gyration = 1.2 m<br>Velocity = 50 km/hr.<br>Location of CG from front axle = 1015 mm<br>Location of CG from rear axle = 1240 mm | **20** | **CO2**<br>**CO4** |

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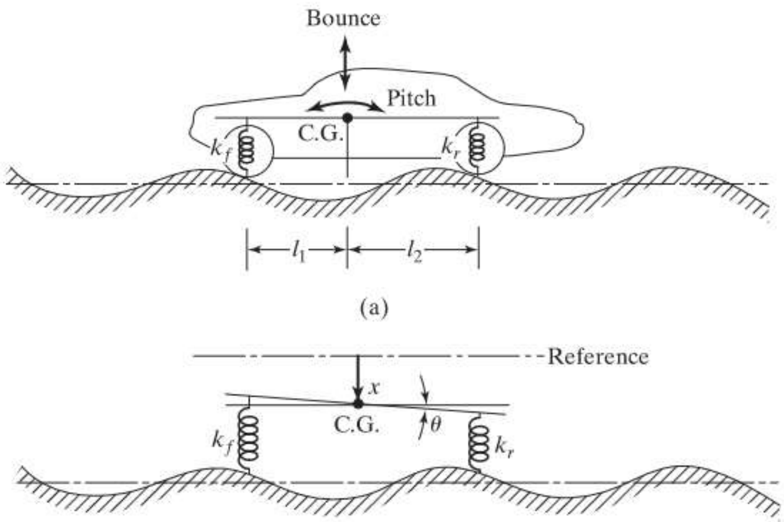
|---|---|---|---|
| | Stiffness of front tire and suspension = 20 kN/m<br>Stiffness of rear tire and suspension = 16 kN/m<br>Also calculate the pitching and bouncing frequency of the car in motion<br> | | |