B.Sc Engg.(M)/7th Sem
B.Sc. Engg. (IPE)/7th Sem

09 October, 2023
Time : 2.30 PM -4.00 PM (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF MECHANICAL AND PRODUCTION ENGINEERING

Mid Semester Examination
Course No.: ME 4703
Course Title: Noise and Vibration

Winter Semester: A.Y. 2022-2023
Time: 1 hour and 30 minutes
Full Marks: 75

There are 3 (Three) Questions. Answer all of them.

Marks in the Margin indicate full marks. Programmable calculators are not allowed.

Assume reasonable values for any missing data(if any).

1. a) The landing gear of an airplane can be idealized as the spring-mass-damper system shown in **Figure 1**. If the runway surface is described by $y(t) = y_0 \cos \omega t$, determine the values of k and c that limit the amplitude of vibration of the airplane (x) to 0.1 m. Assume $m = 2000$ kg, $y_0 = 0.2$ m, and $\omega = 157.08$ rad/s. [13] CO1, PO4/PO2

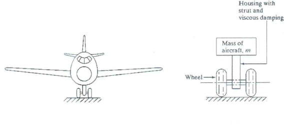

Figure 1. Modeling of landing gear

b) A turbine rotor is mounted on a stepped shaft that is fixed at both ends as shown in **Figure 2**. The torsional stiffnesses of the two segments of the shaft are given by $k_{t1} = 3000$ N-m/rad and $k_{t2} = 4000$ N-m/rad. The turbine generates a harmonic torque given by $M(t) = M_0 \cos \omega t$ about the shaft axis with $M_0 = 200$ N-m and $\omega = 500$ rad/s. The mass moment of inertia of the rotor about the shaft axis is $J_0 = 0.05$ kg-m². Assuming the equivalent torsional damping constant of the system as $c_t = 2.5$ N-m-s/rad, determine the steady-state response of the rotor, $\theta(t)$ [12] CO1, PO4/PO2

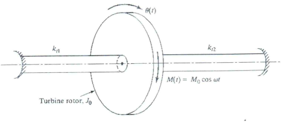

Figure 2

2. a) For the system Shown in **Figure 3**, calculate $x_1(t)$ and $x_2(t)$ for the following initial conditions: [12] CO1, PO4/PO2

$$x_1(0) = 0.2, \dot{x}_1(0) = x_2(0) = \dot{x}_2(0) = 0$$

Consider, $m_1 = m_2 = 1$ kg, $k_1 = 2000$ N/m, and $k_2 = 6000$ N/m.

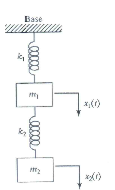

Figure 3

b) A machine tool, having a mass of $m = 1000$ kg and a mass moment of inertia of $J_0 = 300$ kg-m^2, is supported on elastic supports, as shown in **Figure 4**. If the stiffnesses of the supports are given by $k_1 = 3000$ N/mm and $k_2 = 2000$ N/mm, and the supports are located at $l_1 = 0.5$ m and $l_2 = 0.8$ m, find the *mode shapes* of the machine tool. (13) CO1, PO4/PO2

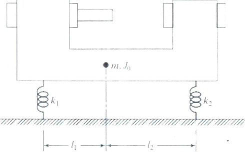

Figure 4

3. a) Consider the following single-degree-of-freedom system with a viscous damper in **Figure 5**. Forming the equation of motion for the system, derive the solutions for *Underdamped*, *Critically Damped* and *Overdamped* Vibration. [17] CO1 PO4/PO2

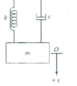

Figure. 5

b) A cylinder of mass m and mass moment of inertia J_0 is free to roll without slipping but is restrained by two springs of stiffnesses k_1 and k_2, as shown in **Figure 6.** Use the **energy method** to find the *natural frequency* of vibration of the system. [8] CO1, PO4/PO2

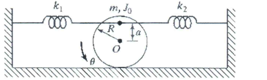

Figure 6