	FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, NIGERIA **SCHOOL OF ELECTRICAL ENGINEERING AND TECHNOLOGY** **DEPARTMENT OF MECHATRONICS ENGINEERING** **FIRST SEMESTER 2019/2020 ACADEMIC SESSION**
	MCE 415: Vibration Analysis and Control
	TIME ALLOWED: 2 HOURS — **CREDIT UNIT:** 2 — **LEVEL:** 400
Instruction: Attempt Any 4 (four) Questions.	

Question 1. (25marks)

Draw and explain the principle of Linear Variable Differential Transformer Transducer as one of the commonly use transducer in vibration measurement. Hence illustrate how the Linearity of voltage with displacement of core could be obtained using graph.

Question 2. (25marks)

The helicopter seat and the pilot weighs 2000 N and is found to have a static deflection of 20 mm under self-weight. The vibration of the rotor is transmitted to the base of the seat as harmonic motion with the frequency 8 Hz and amplitude 0.4 mm. If the seat is modeled as an undamped single-degree-of-freedom system. Compute for the following parameters: (i.) Mass (ii.) Stiffness (iii.) Natural Frequency and Frequency ratio (iv.) The amplitude of the displacement (v.) The level of vibration felt by the pilot

Question 3. (25marks)

Consider a vehicle suspension shown in Figure 1.

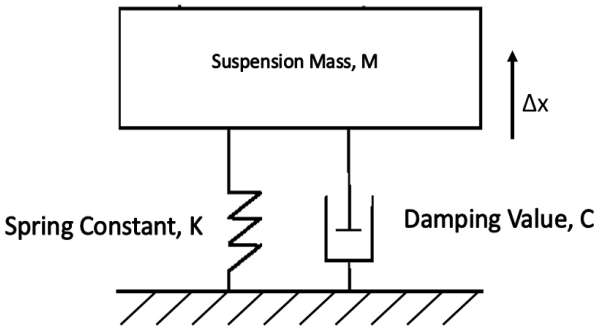

Figure 1: Suspension Model

(a.) Obtain a Transfer Function model of the system.
(b.) Substitute the following values into the system model:
   i. Mass = 7 Kg
   ii. Spring Constant = 2 N/m
   iii. Damping = 4 Ns/m
(c.) Obtain the closed loop poles of the system with a control gain of 2s and unity feedback.
(d.) Make an assertion on the stability status of the system based on the poles obtained.

Question 4. (25marks)

Given that the Mechatronics system represented by the model:

$$G(s) = \frac{3}{s^3 + 2s^2 + 3s + 1}$$

(a.) Determine the stability of the system using Routh Criteria
(b.) Convert the closed loop system model into a State-Space representation.
(c.) Obtain the controllability matrix of the system.
(d.) Obtain the observability matrix of the system.

Question 5. (25marks)

A plant is represented as:

$$\frac{4}{s^2 + 2s + 4}$$

(a.) Based on the poles of the model, is the system stable or not?
(b.) Find the State-Space representation of the system
(c.) With the aid of a suitable diagram, differentiate between single and two degree of freedom system.
(d.) Explain the following terms as used in vibration system analysis with relevance diagram: (i.) Deterministic (ii.) Random