A. Answer the following questions:

1. What is "vibration/oscillation" in a mechanical system?

ANSWER: A vibration/oscillation in a mechanical system is any motion that repeats itself after an interval of time.

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2. What are the different types of vibration?

ANSWER: Two different types of vibrations is a free vibration & a forced vibration.

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3. What do we mean when we refer to as "Theory System"?

ANSWER: These systems could range from simple mechanical systems, like a mass-spring-damper system, to complex engineering structures, such as buildings or bridges subjected to dynamic loads like earthquakes or wind forces.

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4. What are the main components of a vibratory / oscillatory system?

ANSWER: The main components of a vibrational system are springs, dampers, and mass.

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5. How will the components of question (4) make vibration occur in a mechanical system? (Explain from energy point of view)

ANSWER: In a vibratory or oscillatory system, the interplay between mass, springs, and dampers facilitates vibration through the exchange and dissipation of energy. The mass stores and converts kinetic energy, moving under the influence of the spring, which stores and releases potential energy as it is compressed or stretched. This cyclic energy exchange between kinetic (mass motion) and potential (spring deformation) drives the system's oscillations. Meanwhile, the damper removes energy from the system, converting kinetic energy into heat, thereby gradually reducing the amplitude of the oscillations. This dynamic interaction ensures that the system vibrates, with the nature of the vibration—its persistence and characteristics—determined by the balance of energy storage in the mass and spring, and energy loss through the damper.

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6. What is Degree of Degree (DOF)?

ANSWER: Each degree of freedom represents a specific way in which the system can move or be displaced. Essentially, it quantifies the minimum number of independent coordinates needed to specify the position of the system completely at any given instant.

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7. **Draw three systems (apart from the ones in your class notes) with 1 DOF, 2 DOF, and 3 DOF and justify your answer**

1 DOF)

2 DOF)

3) DOF

8. What is a forced and un-forced vibration and mention one example of each.

<u>**ANSWER:**</u>

<u>Forced Vibration</u>: Occurs when an external force is applied to a system, causing it to oscillate at the frequency of the force rather than at its natural frequency. This external force can be periodic, transient, or random, and it dictates the response of the system. An example of this would be a washing machine spin cycle.

<u>Unforced- vibration:</u> Occurs when a system is disturbed from its equilibrium position and then allowed to oscillate without the influence of external forces. The system oscillates at its natural frequency, and the motion is governed solely by its initial conditions and inherent properties (mass, stiffness, and damping). Over time, if the system is damped, the amplitude of the oscillations will decrease until the system comes to rest. An example of this could be a plucked guitar string.

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9. What is a damped and un-damped vibration and mention one example of each

<u>**ANSWER:**</u>

<u>**Damped vibration:**</u> Occurs in a system where energy is gradually lost over time due to resistance forces, such as friction or air drag. These forces counteract the motion, causing the amplitude of the oscillation to decrease gradually until the system comes to rest. An example of a damped vibration is a car suspension system.

<u>**Undamped vibration:**</u> Occurs in an ideal system where there are no forces present to dissipate energy. In such a system, once set into motion, the oscillations would continue indefinitely with a constant amplitude, as there is no mechanism to remove energy from the system. An example of an undamped vibration is an ideal pendulum in a vacuum.

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0. What's the difference between Random and Chaotic vibration and mention one example for each.

<u>**ANSWER:**</u>

A <u>random</u> vibration is non-predictable and an example of this would be a vehicle on a rough road.

A <u>chaotic</u> vibration is non-periodic but predictable and an example of this would be a double pendulum system.

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11. Briefly Explain the four major steps in any Vibration Analysis procedure.

<u>**ANSWER:**</u>

Step 1) Mathematical Modeling: Derive a system using dampers and springs and observe DOF's.

Step 2) Deriving the equations of motion: We derive the Equations of Motion using Newtons 2nd Law, principle of conservation of energy, or the Lagrange's Method

Step 3) **Solution**: Solve the Equations of Motion using Differential Equations.

Step 4) Interpretation of Solution: Assess a "sanity check" with the solutions derived.

B.   Review Questions ~ Page 214 Questions 1 – 16

1. True

2. True

3. True

4. True

5. True

6. False

7. True

8. False

9. True

10. True

11. True

12. True

13. False

14. True

15. True

16. True

C. Problems (Free Vibration undamped/damped) ~ 2.6, 2.9, 2.15, 2.45, 2.64, 2.87, 2.97, 2.129, & 2.130