Fayoum University		3rd Year Industrial Engineering
Faculty of Engineering		Midterm Exam – Nov., 2015
Inustrial Engineering Dept.	Mechanical Vibration	Full Marks: 70, Time:2 Hours

Answer all the following questions:

Question (1): [10 Marks]

Select the most appropriate answer from the multiple choices given:

1. A single-degree-of-freedom system has only one natural frequency.
   (a) True
   (b) False
2. The real part of the solution to the characteristic equation for a single degree of freedom system is zero. Which one of the following best describes the system?
   (a) Underdamped
   (b) Unstable
   (c) Undamped
   (d) Nonperiodic

3. What cause whirling of rotating shafts?
   (b) Mass unbalance
   (c) Fluid friction in the bearings
   (d) Gyroscopic forces
   (e) All above

4. The response of an undamped system under resonance will be:
   (a) Very large.
   (b) Infinity.
   (c) Zero.

5. When parts of a vibrating system slide on a dry surface, the damping is
   (a) Viscous.
   (b) Coulomb.
   (c) Solid.

6. For a forced vibration, the amplitude of vibration is found to depend on the
   (a) Sum of the external frequency and the natural frequency.
   (b) Difference of the external frequency and the natural frequency.
   (c) Product of the external frequency and the natural frequency.
   (d) Ratio of the external frequency and the natural frequency.

7. When a body moves with simple harmonic motion, the product of its periodic time and frequency is equal to
   (a) Zero
   (b) One
   (c) $\pi/2$
   (d) π

8. In a vibrating system, if the actual damping coefficient is 40 N/m/s and critical damping coefficient is 420 N/m/s, then logarithmic decrement is equal to
   (a) 0.2
   (b) 0.4
   (c) 0.6
   (d) 0.8
9. The factor which affects the critical speed of a shaft is
   (a) Diameter of disc
   (b) Span of shaft
   (c) Eccentricity
   (d) All above
10. In vibration isolation system, the transmissibility will be equal to unity, for all values of damping factor, if ω/ω_n is
   (a) Equal to one
   (b) Equal to $\sqrt{2}$
   (c) Less than $\sqrt{2}$
   (d) Greater than $\sqrt{2}$

Question (2): [5 Marks]

Devise a mechanical model for a valve and rocker arm system for an internal combustion engine is given in Figure (Q2).

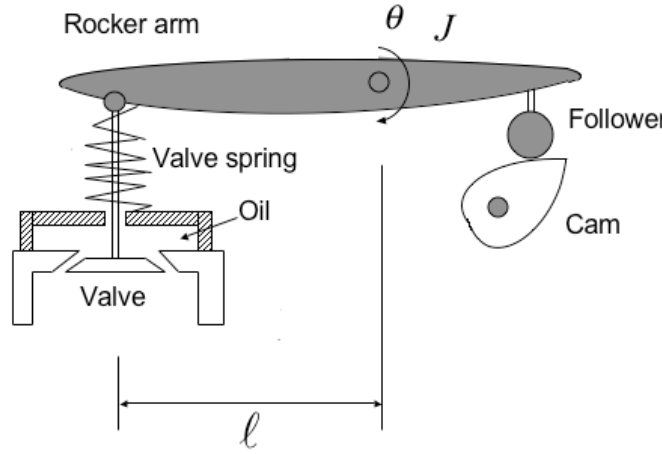

Fig. (Q2).

Question (3): [15 Marks]

Derive the equation of motion of the system in Figure (Q3) and discuss the effect of gravity on the natural frequency and the damping ratio. You may have to make some approximations of the cosine. Assume the bearings provide a viscous damping force only in the vertical direction.

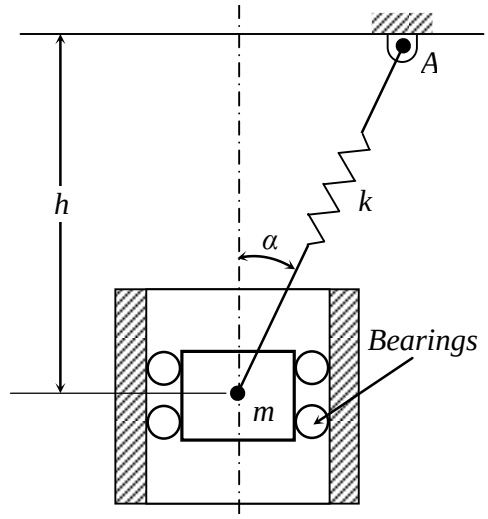

Fig. (Q3)

Question (4): [20 Marks]

A flexible machine part was observed to vibrate badly at frequency of 20 Hz. The vibration was caused by the application of a harmonic force of unknown amplitude to the flexible part. A judgment was made that the vibration was excessive because the frequency of the harmonic force coincided with the natural frequency of the flexible part.

(1) When the harmonic force was not present, a 0.5 kg mass was placed on the flexible part, and a static displacement of 3 mm was observed. If the flexible part was be modeled as a spring-mass-damper system, what value of equivalent stiffness k and mass m would be appropriate?

(2) Design an absorber with a mass of 0.03 kg that would eliminate vibrations of the flexible part at frequency of 20 Hz.

(3) If the amplitude of the motion of the absorber mass at 20 Hz was observed to be 1 cm, what was the amplitude of the harmonic force that caused the flexible part to vibrate?

Question (5): [20 Marks]

A machine of mass m=0.5 kg is subjected to harmonic force of unknown amplitude F_0 that remains constant. The machine is connected to a rigid base with a spring of stiffness k=31.6 kN/m. the spring is known to exhibit a damping ratio ζ=0.2. When the frequency of the harmonic force applied to the mass is 40 Hz, the force transmitted to the base is maximized at 30 N.

(1) What is the force F_0 subjected to the machine?

(2) What is the amplitude of the motion of the machine?

(3) Replace the damped spring with an undamped spring that will reduce the amplitude of transmitted force to 5N

Best wishes

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