| Fayoum University | | 3rd Year Industrial Engineering |
|---|---|---|
| Faculty of Engineering | | Final Exam – Jan., 2016 |
| Mechanical Engineering Dept. | Mechanical Vibrations | Time:3 Hours |

*Answer all the following questions*

**Question (1)**

**a.** Explain the steps for solving and analysis a vibration problems with neat sketch.

**b.** A vibrating system consists of block has a mass of 20 kg, and spring has a stiffness $k$ = 600 N/m. When the block is displaced and released, two successive amplitudes are measured as $x_1$ = 150 mm and $x_2$ = 87 mm. What is the damping condition of the system?

**Question (2)**

**a.** Define the whirling of rotating shafts phenomenon and discuss graphically the effect of the shaft angular speed $\omega$ on variation of center deflection $r$.

**b.** The schematic diagram of a large cannon is shown in ***Figure (Q2.b)***. When the gun is fired, high pressure gases accelerate the projectile inside the barrel to a very high velocity. The reaction force pushes the gun barrel in the direction opposite that of the projectile.

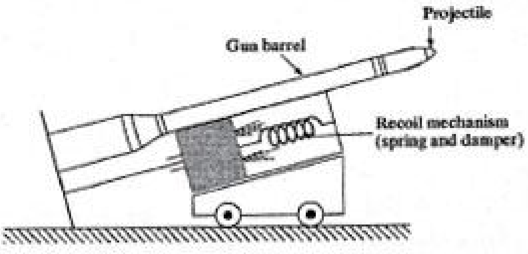


***Fig. (Q2.b)***

Since it is desirable to bring the gun barrel to rest in the shortest time without oscillation, it is made to translate backward against a critically damped spring-damper system called the *recoil mechanism*. In a particular case, the gun barrel and the recoil mechanism have a mass of 500 kg with a recoil spring of stiffness 10,000 N/m. The gun recoils 0.4 m upon firing. Find **(i)** the critical damping coefficient of the damper, **(ii)** the initial recoil velocity of the gun, and **(iii)** the time taken by the gun to return to a position 0.1 m from its initial position.

**Question (3)**

**a.** Graphically, explain the relation between transmissibility and frequency ratio response.

**b.** A steel shaft of diameter 2.5 cm and length 1 m is supported at the two ends in bearings. It carries a turbine disc, of mass 20 kg and eccentricity 0.005 m, at the middle and operates at 6000 rpm. The damping in the system neglected. Determine the whirl amplitude of the disc at **(i)** operating speed, **(ii)** critical speed, and **(iii)** 1.5 times the critical speed.

***Please turn over***

**Question (4)**

**a.** What are the various methods available for vibration control, with examples?

**b.** A pipe carrying steam through a section of a factory vibrates violently when the driving pump hits a speed of 232 rpm. In an attempt to design an absorber, a trial 1 kg absorber tuned to 232 rpm was attached. By changing the pump speed, it was found that the pipe-absorber system has a resonance at 198 rpm. Redesign the absorber so that the natural frequencies are less than 160 rpm and more than 320 rpm.

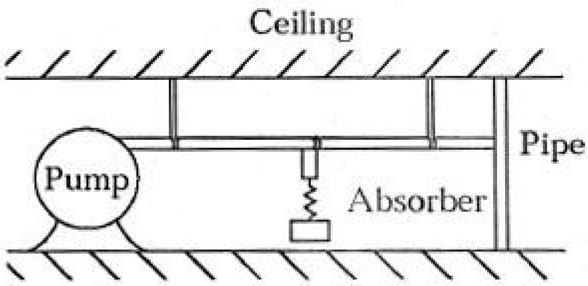


*Fig. (Q4.b)*

**c.** For a rotor system with a circular shaft as shown in ***Figure*** **(*Q4.c*)** obtain the torsional natural frequencies, mode shapes, and nodal position. Consider the free-free end conditions. Neglect the polar mass moment of inertia of the shaft and take $G = 0.8 \times 10^{11}$ N/m$^2$.

$$J = \frac{\pi \times d^4}{32} \text{ and } k_t = \frac{GJ}{l}$$

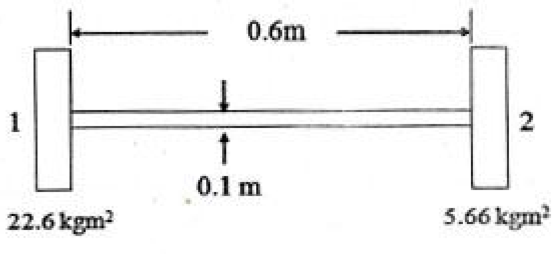


*Fig. (Q4.c)*

*Best wishes*

***Dr. Emad M. Saad***