Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

VII SEMESTER B.TECH (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, DEC 2015/JAN 2016

SUBJECT: THEORY OF VIBRATIONS [AAE- 401]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

1A. A prototype composite material is formed and hence has unknown modulus. An experiment is performed consisting of forming it in to a cantilever beam of length 1 meter and moment I=10^{-9} m^4 with a 6 kg mass attached at its end. The system is given an initial displacement and found to oscillate with a period of 0.5 s. Calculate the modulus *E*. **(05)**

1B. Consider two harmonic motions of different frequencies $x_1(t) = 2cos2t\ and\ x_2(t) = cos3t$. Is the sum $x_1(t) + x_2(t)$ a harmonic motion? If so what is its period. **(03)**

1C. Define (i) Transmissibility (ii) Critical damping (iii) Damping ratio and (iv) Forced vibration. **(02)**

2A. The ratio of successive amplitudes of a viscously damped SDOF system is found to be 18:1. Determine the ratio of successive amplitudes if amount of damping is (i) doubled and (ii) halved. **(03)**

2B. The schematic diagram of large cannon is shown in Fig.1. 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 opposite direction of the projectile. 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 A) the critical damping coefficient of the damper, B) the initial recoil velocity of the gun, and C) the time taken by the gun to return to a position 0.1 m from its initial position. **(05)**

2C. A mass, when suspended by a helical spring, have a natural frequency 125 cps. Now the spring cut two equal halves and the same mass is suspended by both the halves in parallel. What will be the natural frequency of the new system? **(02)**

3A. Instrument panel of 25kg mass of an aeroplane must be isolated from an engine vibrating with amplitude of 0.2mm at 10000rpm. The instrument panel is mounted on 4 isolators each having stiffness of 40kN/m and a damping constant of 400 N-s/m. Determine **(05)**

(i) Amplitude of vibration of the panel

(ii) Dynamic load on each isolator due to vibration.

3B. A disc of mass 4 kg is mounted midway between bearings which may be assumed to be simple supports. The bearing span is 0.5 m. The steel shaft is of 10 mm diameter and horizontal. The centre of gravity of the disc is displaced 2 mm from the geometric centre. The equivalent viscous damping at the centre of the disc shaft may be assumed as 50 N-s/m. If the shaft rotates at 250 rpm, determine the maximum stress in the shaft. Also find the power required to drive the shaft at this speed. **(05)**

4A. Define co-ordinate coupling and derive an equation for the same clearly stating the coupling component. **(04)**

4B. Determine the natural frequencies of the system shown in fig.2. (Assume a =1 , k =1 units) **(06)**

5A. Using Rayleigh's method, determine the fundamental frequency of lateral vibrations of the system shown in fig.3. Take Young's Modulus of shaft = 200GPa. **(05)**

5B. Define the following: **(05)**

(i) Free Vibration (ii) Simple Harmonic motion (iii) Zero frequency deflection (iv) Viscous Damping (v) Coulomb Damping

6A. What do you understand by Normal mode of vibration and mode shapes? **(02)**

6B. Determine the natural frequencies of the system using Stodola's method for the fig.4. **(08)**

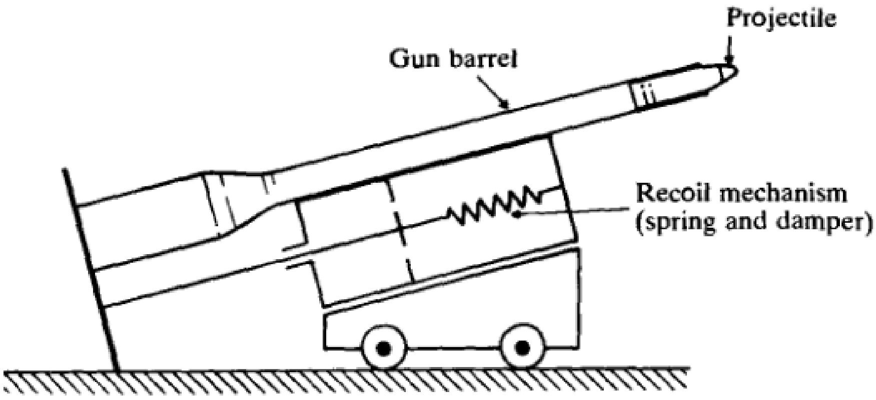
Projectile
Gun barrel
Recoil mechanism
(spring and damper)

FIG.1.

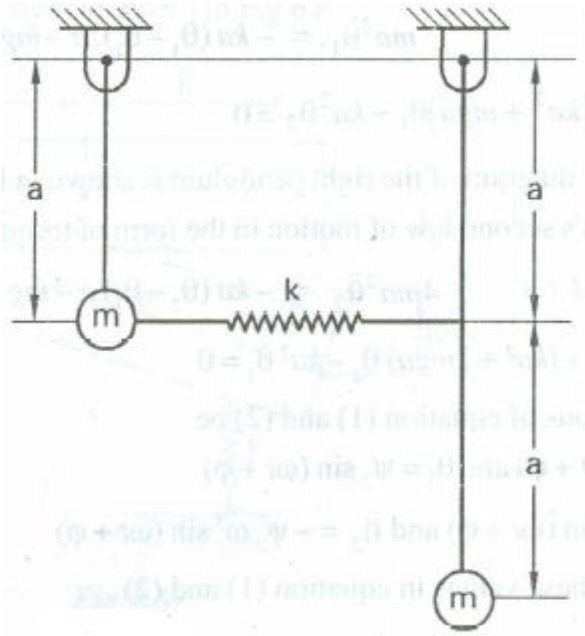
a
a
k
m
a
m

FIG.2.

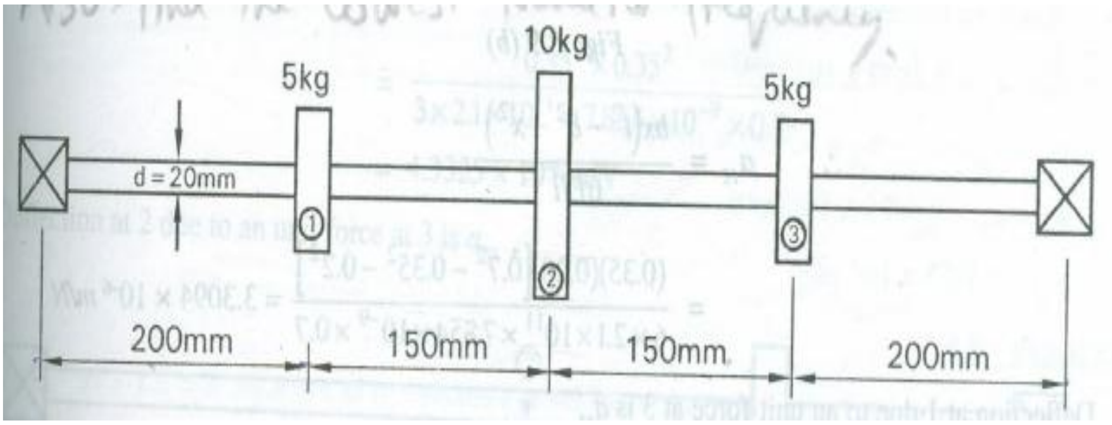
10kg
5kg
5kg
d = 20mm
1
2
3
200mm
150mm
150mm
200mm

FIG.3.

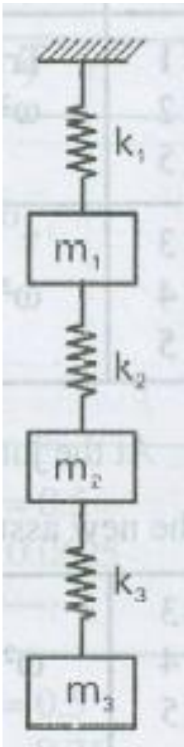
k_1
m_1
k_2
m_2
k_3
m_3

FIG.4.