Reg.No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

VII SEMESTER B.TECH. (AERONAUTICAL/AUTOMOBILE ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2019

SUBJECT: THEORY OF VIBRATIONS [AAE -4101]

REVISED CREDIT SYSTEM

(15/11/2019)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Show that sum of 2 harmonic functions of the same frequency but with different phase angles is also a harmonic function of the same frequency. **(04)**

1B. Determine the stiffness in the following cases **(02)**

i. The torsional stiffness of a solid aluminium shaft of length 2m and radius 20cm. The shear modulus of rigidity is 41GPa.

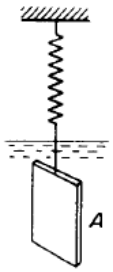
ii. The longitudinal stiffness 1m long beam with cross section area $3\text{x}10^{-4}$ m^2 and E= 200GPa

1C. A block of mass 0.0647 kg is suspended from a spring of stiffness 50 N/m. The block is displaced downwards from its mean position by 2cm and released upwards with a velocity of 3 cm/s. Determine (a) the natural frequency, (b) time period, (c) maximum velocity (d) maximum acceleration and (e) the phase angle **(04)**

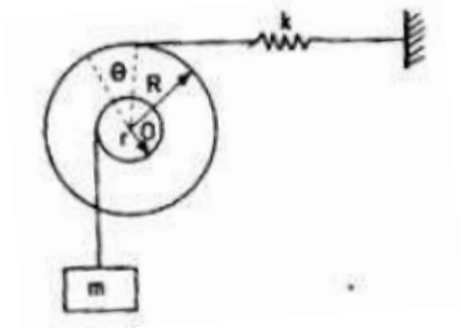
2A. A thin plate of area A and weight W is attached at the end of a spring and allowed to oscillate in a viscous fluid as shown in the figure. If τ_1 is the natural time period of undamped oscillation (that is the system is oscillating in air) and τ_2 the damped period with the plate immersed in the fluid, show that **(05)**

$$\mu = \frac{2\pi W}{gA\tau_1\tau_2}\sqrt{\tau^2{}_2 - \tau^2{}_1}$$

Where, the damping force on the plate is $F_d = 2\mu Av$, $2A$ is the total surface area of the plate and v is the velocity.



2B. Obtain the governing differential equation for the following system. Take $R=4r$ **(03)**



2C. Under what conditions a system becomes non-oscillatory and what is the physical significance of that? **(02)**

3A. A SDOF viscous damping system makes 5 complete oscillations per second. Its amplitude diminishes to 15% in 60 cycles. Determine (a) the logarithmic decrement and (b) damping ratio. **(04)**

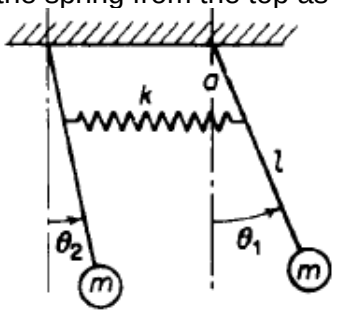
3B. Soldiers are advised not to march on abridge to avoid resonance conditions. But how does heavy vehicle like trailer trucks or buses do not create the resonance conditions? **(03)**

3C. A 30 kg is mass is mounted on an isolator pad with stiffness of $5x10^5$ N/m. When the system is subjected to harmonic excitation of magnitude 325 N and frequency of 100 rad/sec, the phase difference between the excitation and the steady state response is 25 deg. Determine (a) damping ratio of the isolator pad and (b) the isolator pad's maximum deflection due to this excitation. **(04)**

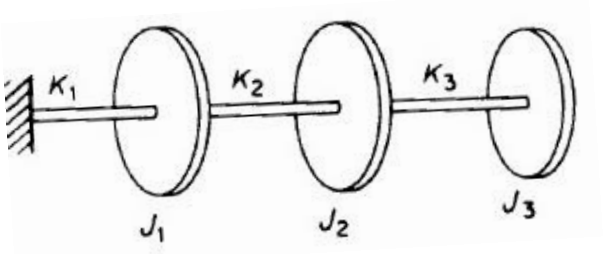
4A. An electric generator weighing 981N operating at 600 rpm is mounted on 4 parallel springs of stiffness 5000 N/m each. Determine the maximum permissible unbalance in order to limit the steady state displacement to 6mm peak to peak. **(03)**

4B. Discuss why the accelerometers have very high natural frequency. **(02)**

4C. Determine the natural frequencies of the following system. Take the length of pendulum as *l* and distance of the spring from the top as *a*. **(05)**



5A. Express the governing differential equations of the following system using flexibility influence coefficient approach. **(02)**



5B. Find out the natural frequencies and mode shapes of the system shown in question 5A. **(06)**
Where, $J_1=J$, $J_2=2J$ and $J_3=4J$.and $K_1=K$, $K_2=2K$ and $K_3=4K$

5C. Determine the first natural frequency of the system in question 5A by Dunkerly's method and find the percentage error. **(02)**