Major Examination on Vibration Engineering (MEL 733)
Instruction: Answer all the questions.

Date: 02/12/2006
Full Marks: 50
Time: 1hour

Part-I (Closed Book)

Problem-1

(a) Write down the equation of motion for free bending vibration of a simply supported uniform beam. Also write the boundary conditions. Prove that any two un-damped modes of vibration are orthogonal. What is its physical interpretation? (1+1+2+1)

(b) An airplane wing has the first natural frequency of 1600 Hz in torsion. A fuel tank is attached to the wing and due to this the moment of inertia about the axis of torsion becomes 21 kg-m2. The stiffness of the wing in torsion is 7e5 N-m/radian. Find the new natural frequency of oscillation due to torsion caused by the additional attachment of the fuel tank (5)

Problem-2

(a) The following table shows the amplitude of vibration and corresponding phases during balancing of an alternator rotor at two planes. Determine proper balancing masses with their locations assuming the radii of balancing masses same as those of the trial masses.

Trial	Trial Mass (kg)	Left Plane Amplitude	Right Plane Amplitude
1	0	3e-4 cm. at 15 deg.	4e-4 at 75 deg.
2	2 at left plane	4e-4 cm. at 80 deg.	3.5e-4 at 85 deg.
3	2 at right plane	5 e-4 cm. at 100 deg.	2.5e-4 at 110 deg.

(5)

(b) Draw a schematic diagram showing the feedback control loop for active vibration control of a single degree of freedom spring-mass-damper system excited by an arbitrary disturbance. Give brief explanation of the process. (5)

Part-II (Open Book)

Time: 1 hour

Problem-1

(a) What is the degree of freedom of the vibratory system shown in figure-1? Find the equation of motion for free vibration. Find the un-damped natural frequency. (1+3+1)

(b) Schematic diagram of a rotating leaf spring is shown in figure-2, where the spring is modeled as a cantilevered beam with an end mass. The rotor rotates at an angular speed Ω. Ignoring the mass of the beam, find the natural frequency of oscillation of the spring. Assume that the slope of the beam due to bending is small. (5)

Problem-2

(a) Design the stiffness of an un-damped vibration isolator for a 10 kg variable speed pump to provide 80% isolation. The speed of operation of the pump varies between 1500 to 2000 rpm. (5)

(b) In an experiment to find the coefficient of friction between two materials a 10 kg block was placed on an inclined plane and attached to the wall with a spring of stiffness 10000 N/m as shown in figure-3. Setting the block to motion by giving a prior displacement, the amplitude of vibration was seen to decrease by 1.5 mm per cycle.
Find the coefficient of friction μ between the surfaces. (2)
A new block of same material but of mass 5 kg is placed on the incline and is set to motion with a prior displacement of 20mm. How many cycles of motion will the block execute? (3)

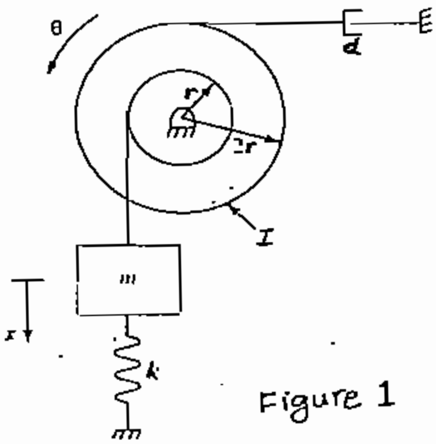

Figure 1

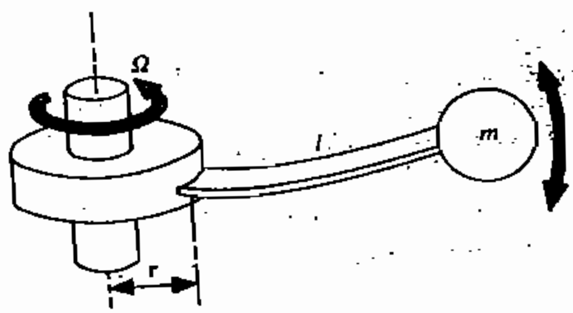

Figure-2

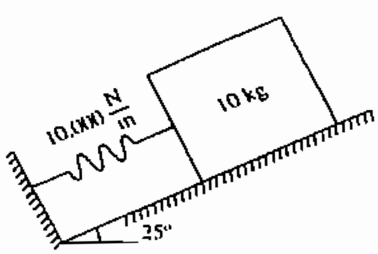

Figure-3

PTO.

Problem-3

Write the equations of motion and determine the natural frequencies of the system shown in figure 4 with the following data. (10)

$m = 20$ kg	$b = 0.25$ m
$I = 0.3$ kgm^2	$h = 0.1$ m
$K_1 = 10$ kN/m	$\phi = 30°$
$K_2 = 18$ kN/m