MECH 364: MECHANICAL VIBRATIONS
MIDTERM EXAMINATION 2

Time: 45 minutes   23rd February 2011   Maximum Available Mark: 20

PLEASE READ THE QUESTION CAREFULLY.

Q1. An electric motor has a mass of $m = 10$ kg and is set on four identical springs, situated at four corners, <u>each</u> with a spring of modulus 1.6 N/mm, as shown below (front view shown). The radius of gyration of the motor assembly is $r_0 = 100$ mm about the shaft axis: pointing out of the plane of the paper and passing through the centre point. The running speed of motor is 3000 rpm. The spacing between springs is 250 mm as shown below.
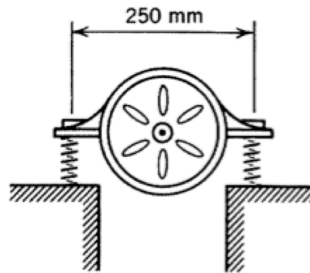

Figure 1: Front view of the motor.

a) Using appropriate Free Body Diagrams (FBDs), determine the natural frequencies **(14 marks)** for the vertical (up-down) vibrations and torsional vibrations (tilting) about the shaft axis: pointing out of the plane of the paper. Note that mass moment of inertia, J, is obtained from radius of gyration r_0 and mass m via $J = mr_0^2$. *State your assumptions and clearly label the FBDs indicating appropriate co-ordinate(s).*

b) Where will you place an additional mass in order to decrease the natural frequen- **(3 marks)** cies of the vertical and torsional vibrations? Where will you place an additional stiffness if the design requirement is to increase the natural frequencies for both vertical and torsional vibrations?

c) Where will you place an additional mass in order to decrease the natural frequency **(3 marks)** of the vertical vibration **without changing the torsional natural frequency**?

ALL THE BEST!