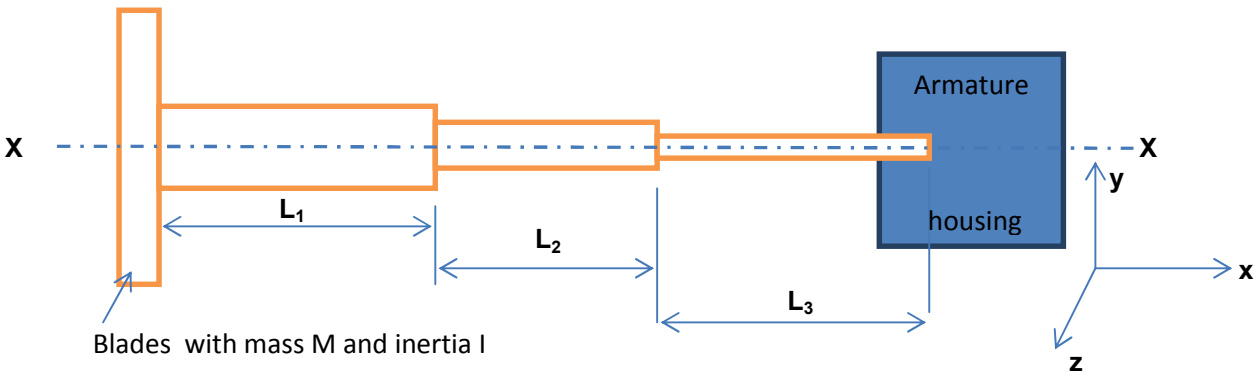
**Question 3**

**LO.3 Dynamic parameters of power transmission systems.**

a. Shown below is a simplified diagram of a stepped turbine shaft:




Wind hits the turbine blades with a pressure **P** Pa in a direction which may be averaged out at 90 degrees to the y-axis, creating a torque **Ta,** which acts clockwise in the x-direction as we look at the diagram from the left hand side.

We may assume that the transmission shaft L1, L2 and L3 is the same material machined to different diameters $\mathbf{d_1}$, $\mathbf{d_2}$ and $\mathbf{d_3}$ respectively, having a young's modulus of **E** ($N/m^2$), and a rigidity modulus of **G**($N/m^2$).

The armature housing contains the armature and associated electrical system to generate current for the grid. This armature is housed on bearings having a damping constant of **c** ($N^{1/2}$), which provides a resistive torque to the system.

a. Design an equation that describes the power transmission over the length of the shaft up to and including the armature housing. Assume that the blades of the turbine may be modelled as a disc with Mass **M** , radius **r** and gyration radius **k**. Ignore the fillet radii between shafts and simply treat as a 90 degree turn.

b. Derive an equation that describes the maximum displacement of the centre of rotation of the shaft turbine blades from the axis "XX" assuming that the transmission shaft has a weight of W newtons. State clearly in your analysis any assumptions that you have made.

c. A block of ice having a mass β falls from a plane and hits the blades at an angle of ø to the vertical y-axis. What happens to the transmission shaft? Explain analytically in detail stating any assumptions that you have made.

p.t.o……