

**ME 256**  
**Variational Methods**  
**And**  
**Structural Optimization**

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1Q. Given the displacement field of a Timoshenko beam as

$$u(x, y, z, t) = z * \theta(x, t) \quad \text{where } \theta(x, t) \neq \frac{\partial w}{\partial x}$$

$$v(x, y, z, t) = 0$$

$$w(x, y, z, t) = w(x, t)$$

where  $u(x, y, z, t)$  is the axial displacement,  $v(x, y, z, t)$  and  $w(x, y, z, t)$  are the transverse displacements in  $y$  and  $z$  directions respectively. Using Hamilton's principle of variation derive the equation of motion and also write the necessary boundary conditions.