**VISCOELASTIC SOLIDS**

**Quiz 1**

Show logic and state all principles and assumptions used.

Given: \( J'(\omega) = \frac{2\omega}{\pi} \int_0^\infty \frac{J'(\omega) - J'(\infty)}{\omega^2 - \omega_0^2} d\omega \)

\( J(\omega) - J'(\infty) = \frac{2}{\pi} \int_0^\infty \frac{\omega J'(\omega)}{\omega^2 - \omega_0^2} d\omega \), \( \omega(t) = \frac{E(t-\tau)}{d\varepsilon/d\tau} d\tau \), \( 1 \text{ N} = 10^5 \text{ dyne} \)

\[ \mathbf{L}^{(0)} = \mathbf{F}(s) = \int_0^\infty \frac{f(t)}{s} e^{-st} dt \quad \frac{d^2 f(t)}{dt^2} = s^2 \mathbf{L}[f(t)] - f(0), \quad E = 2G(1 + \nu) \]

\[ \mathbf{L}^{[\sin(at)e^{-bt}]} = \frac{a}{(s+b)^2 + a^2} \]

1 (30 pts) Define the following using one or two sentences, or if appropriate, by an equation

(a) Creep

(b) Stress relaxation

(c) Recovery

(d) Power law

(e) Storage modulus

(f) Time-temperature superposition

(g) Aging

(h) Passive material

(i) Dirac delta

(j) Convolution

2 (30 pts) Show that for a linearly viscoelastic material, \( \int_0^1 J(t - \tau)G(\tau) d\tau = t \) in which \( G(t) \) is the relaxation modulus for shear and \( J(t) \) is the corresponding creep compliance.

(5 pts) Can you think of an explicit interrelation for a particular \( J(t) \)?

3 (a) (30 pts) Use the Boltzmann superposition principle to obtain [as an equation] the strain response to the following stress history. Sketch the strain history. Assume any needed mechanical properties are known.

(b) (5 pts) Develop an approximation for time \( t \gg T \) for the viscoelastic response based on derivatives of the appropriate viscoelastic function.