

FIGURE 4.1 Oscillating a sample: When a sample is subjected to a sinusoidal oscillating stress, it responds in a similar strain wave provided the material stays within its elastic limits.

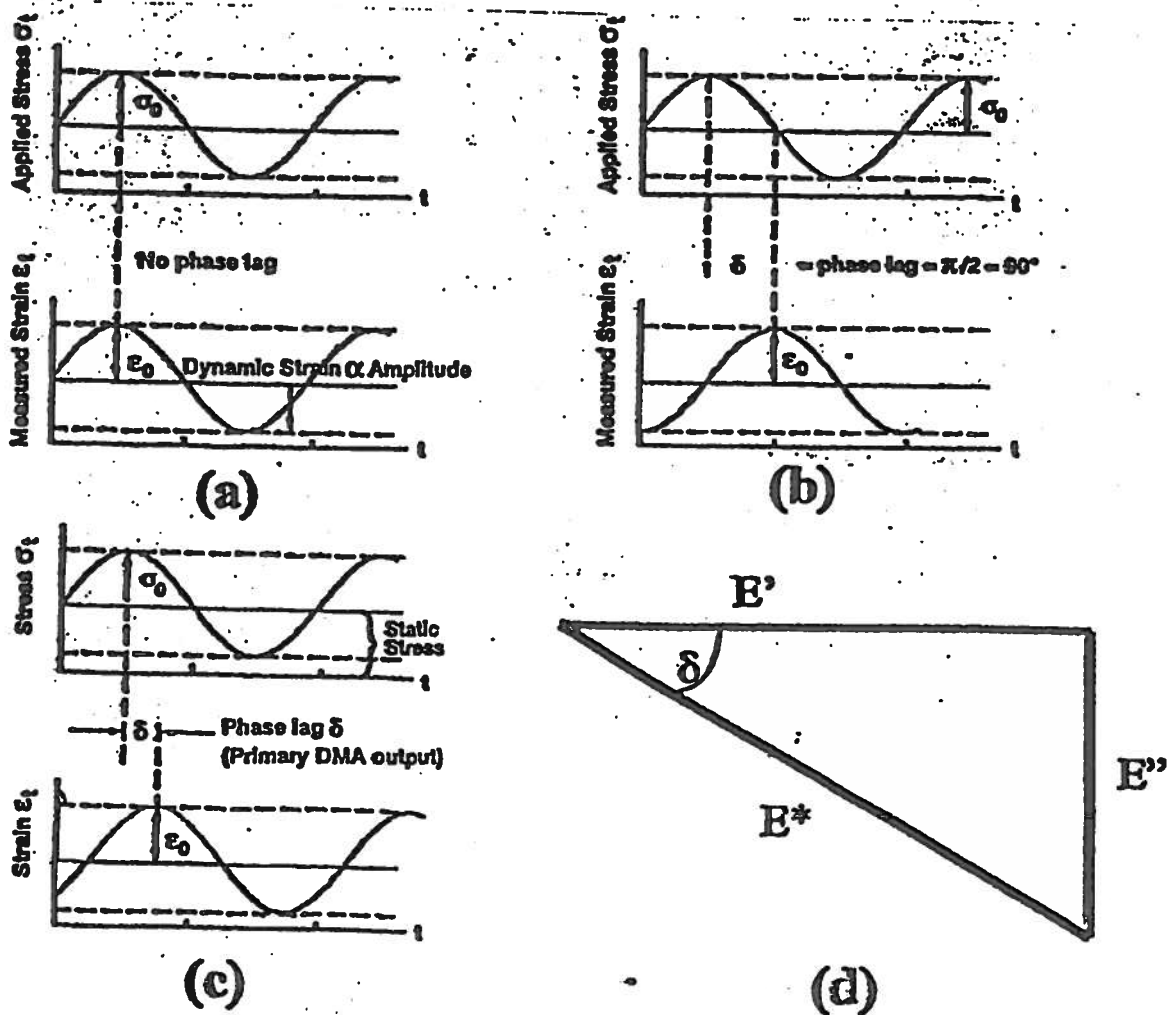
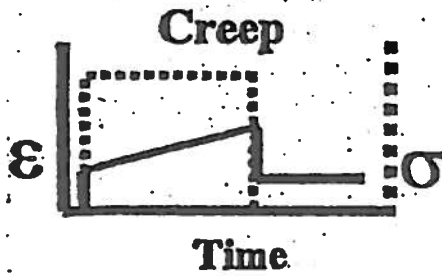
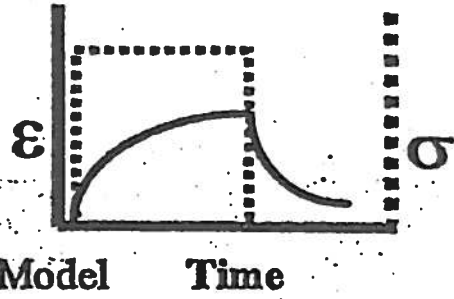
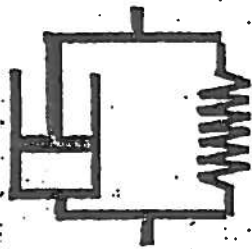


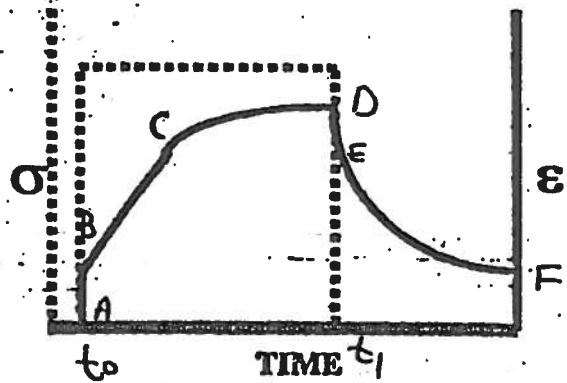
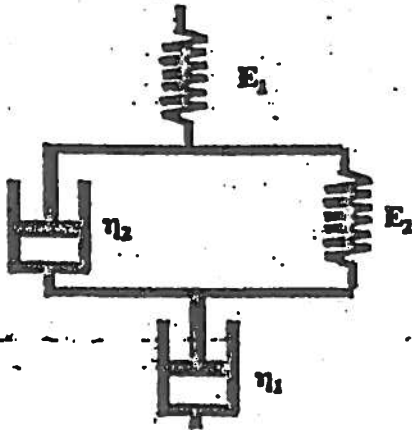
FIGURE 4.2 Responses. When the material responds to the applied stress wave as a perfectly elastic solid, an in-phase response is seen (a), while a purely viscous material gives an out-of-phase response (b). Viscoelastic materials fall in between these two lines, as shown in (c). The relationship between the phase angle,  $E'$ ,  $E''$ , and  $E^*$ , is graphically shown in (d). (Used



(a) Maxwell Model



(b) Voigt Model



(c) 4 Element Model

**FIGURE 3.5** Models for approximating creep-recovery response. Neither the Maxwell (a) nor the Voigt (b) model work well to explain creep. The four-element model (c) does a better job.

Phenomenological Aspects of Viscoelastic Behavior

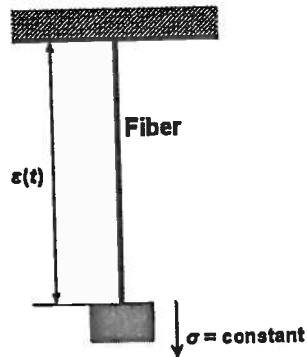


Figure 16.3. Creep test of a viscoelastic fiber.

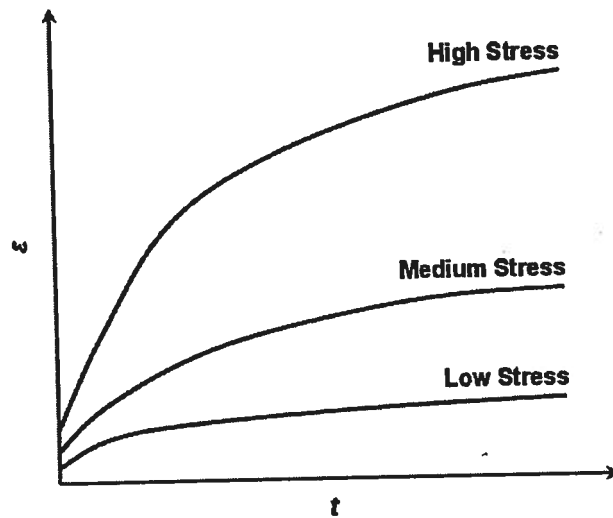
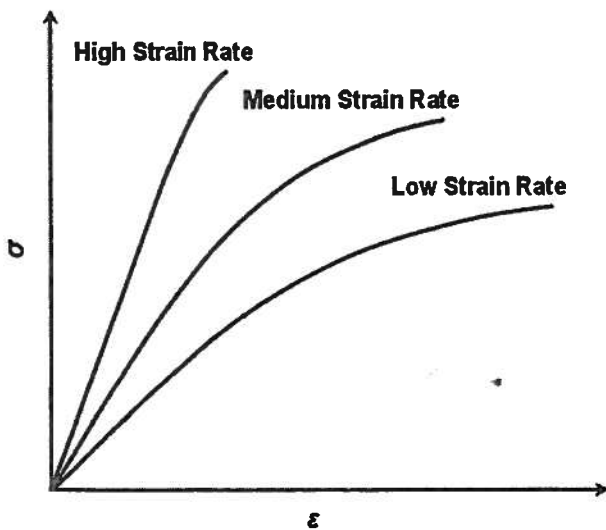
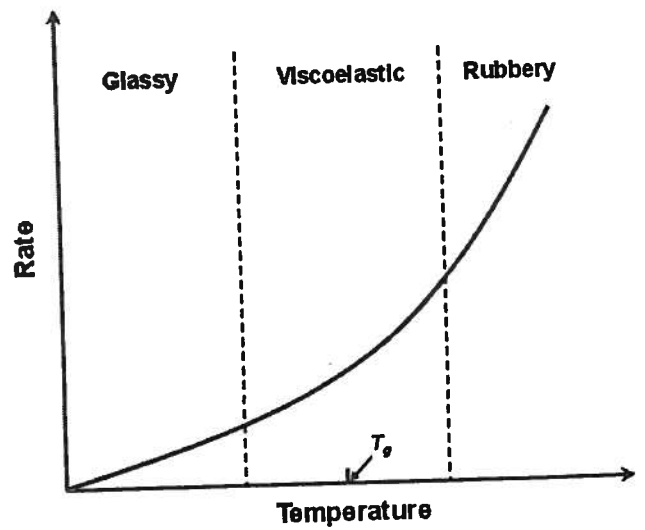


Figure 16.4. Creep of a typical polymer fiber under different constant stresses.



16.2. Effect of strain rate on the stress-strain behavior of polymer fibers.



16.1. Relationship between conformational change rate and temperature.

### VISCOELASTIC PROPERTIES OF FIBERS

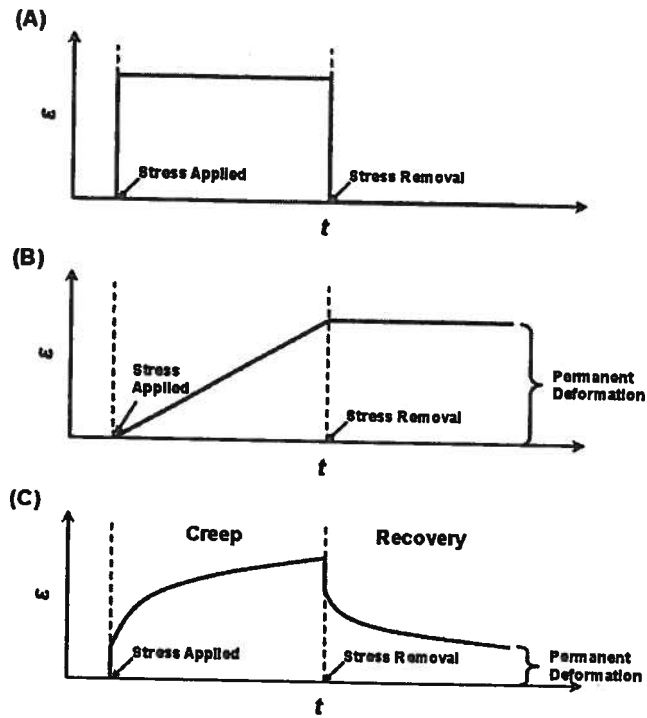


Figure 16.5. Typically strain-time curves of (A) ideal elastic material, (B) ideal viscous material, and (C) viscoelastic polymer fibers under constant stress.

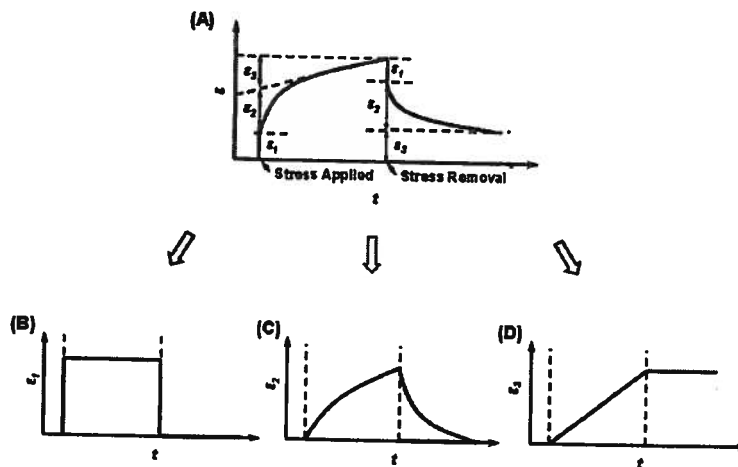


Figure 16.6. (A) Creep-recovery curve of a viscoelastic polymer fiber, and the corresponding (B) elastic, (C) retarded, and (D) viscous components.

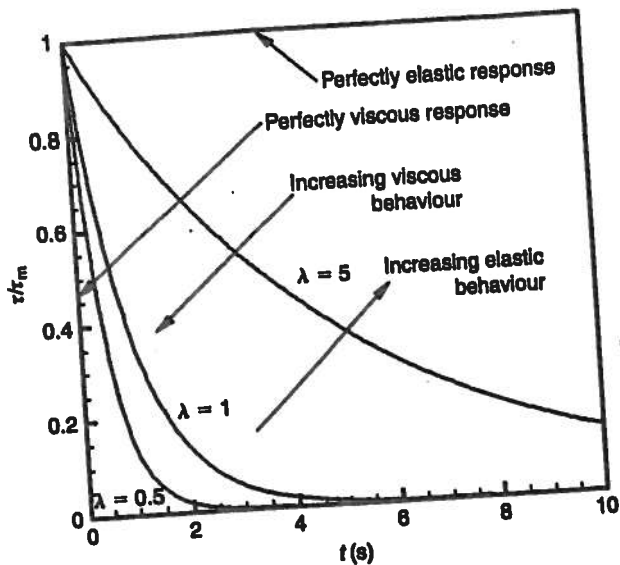


Figure 1.27 Stress decay behaviour of a Maxwell fluid in a strain-jump experiment

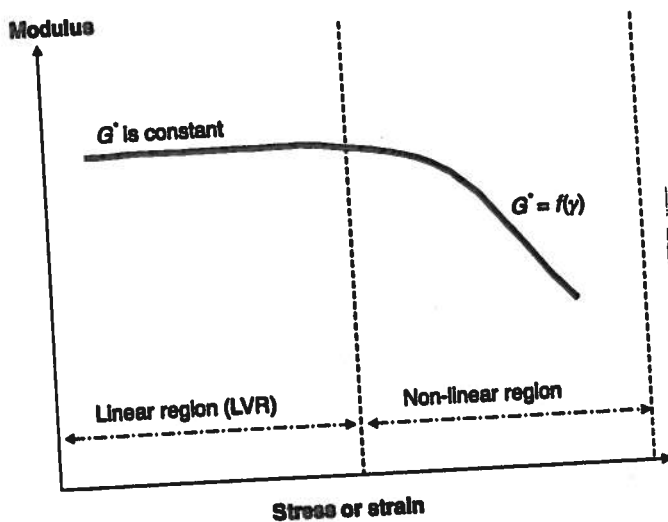


Fig. 2.4 Linear and non-linear stress-strain behaviour.

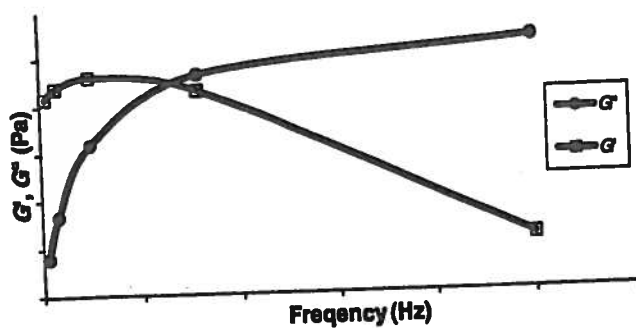


Fig. 2.6 A typical graph of viscoelastic modules and their frequency dependency.

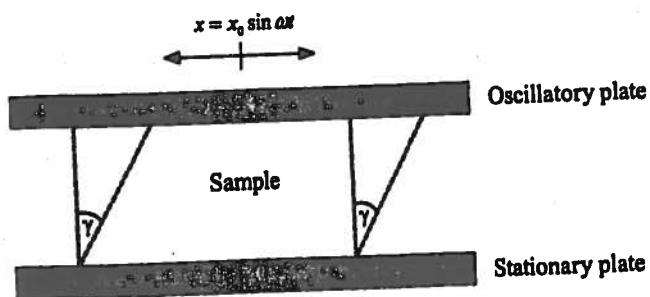


Fig. 2.5 Simplified schematic of an oscillatory test.