Question 1 – A polymer-nanocomposite when subjected to a step stress, the creep compliance shows two step exponential increase followed by creep compliance plateau. Answer the following –

1. Suggest a mechanical model consisting of spring and dashpot elements, which can capture the above-mentioned experimental behaviour.
2. Solve your proposed mechanical model for step stress test and show the creep-compliance indeed shows two step exponential increase with an ultimate plateau.

Question 2 – Using Boltzmann superposition principle, show that zero shear viscosity for any material can be expressed as integration of relaxation modulus from 0 to infinity in linear regime deformation.

Using Boltzmann superposition principle, obtain the expression for G’ and G’’ as a function fo angular frequency (w) in terms of the relaxation modulus (G(t)).

Hence prove that zero shear viscosity is given by limit w tends to 0 G’’/w (w is the angular frequency).

Question 3 – Under what criterion the dynamic moduli (storage and loss modulus), show power law dependence on frequency with exponent 2 and 1 respectively, within linear regime stress/ strain amplitude)? Provide mathematical support to your answer.

Question 4 – Answer the following :

1. Hower Linear Viscoelastic regime depends on frequency of imposed strain/stress field, kindly show four curves on a single plot in proper order for different frequencies (w1<w2<w3<w4)?
2. How can you get a rough estimate of relaxation time scale using frequency sweep test in linear regime?

Question 5 – Consider a mechanistic rheological model consisting of 2 springs and 1 dashpot. 1 spring on the left arm and 1 spring and dashpot in series in the other arm.

1. Obtain the expression of creep compliance (J(t)) and relaxation modulus (G(t)) for this model if in step stress test first the stress increases linearly upto t1, stress at that point being k\*(t1) and then remaining constant for the remaining time.
2. Hence obtain the strain at time t>t1 for the stress profile shown below using Boltzmann’s superposition principle.