

# Unit 3 - Viscoelasticity and Introduction to polymers

**Course outline**

How does an NPTEL online course work?

**Introduction to viscoelasticity**

**Viscoelasticity and Introduction to polymers**

- Creep and stress relaxation functions
- Linearity
- Mechanical Analogues
- Tutorial**
- Quiz : Week 2 Assessment**

**Viscoelasticity and Introduction to polymers**

**Constitutive Equations**

**Viscoelastic models**

**Viscoelastic models**

**Viscoelastic models (cont.) & Constitutive modelling**

**Response to Sinusoidal oscillations**

**Weekly Feedback forms**

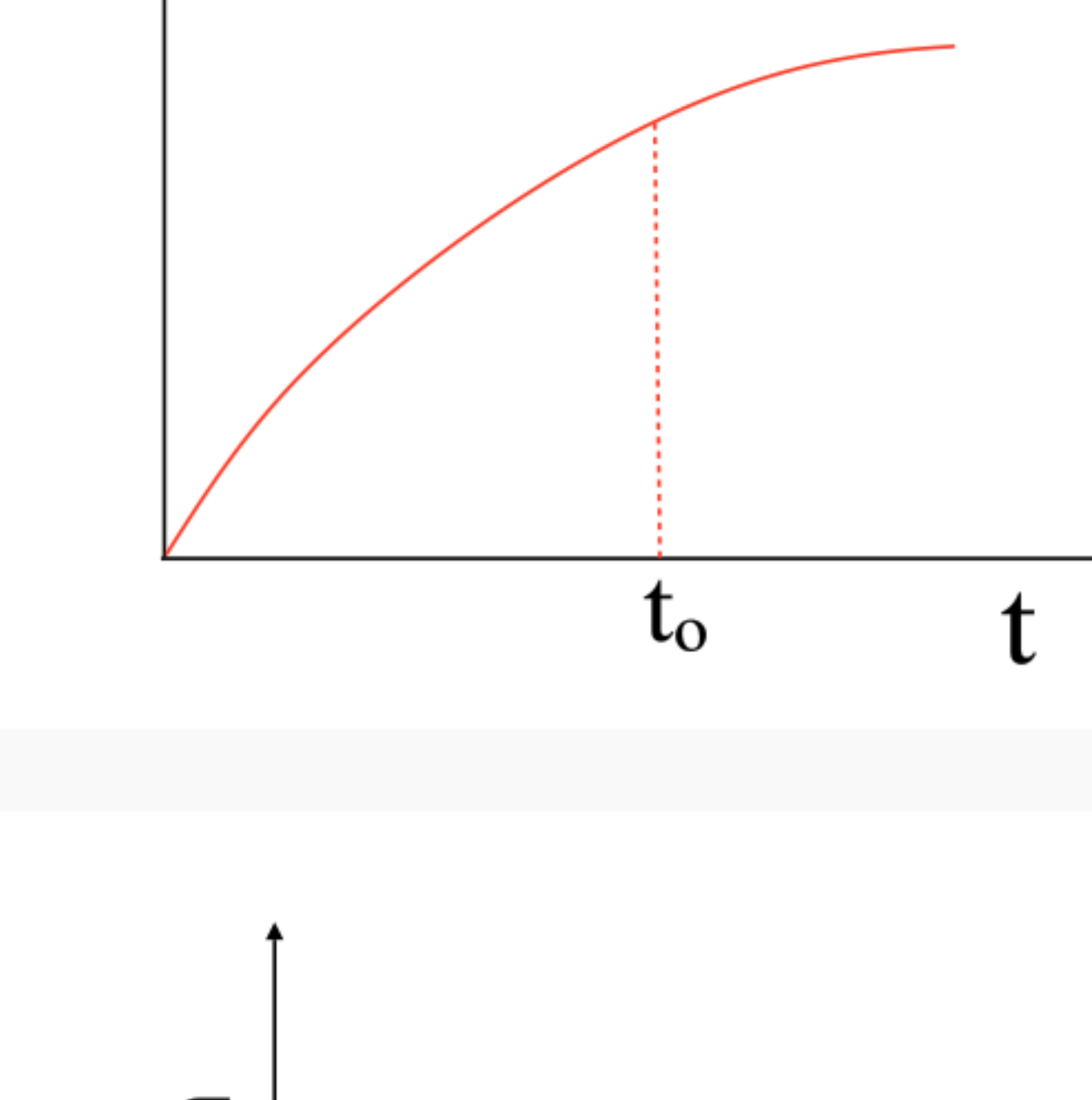
**Text Transcripts**

## Week 2 Assessment

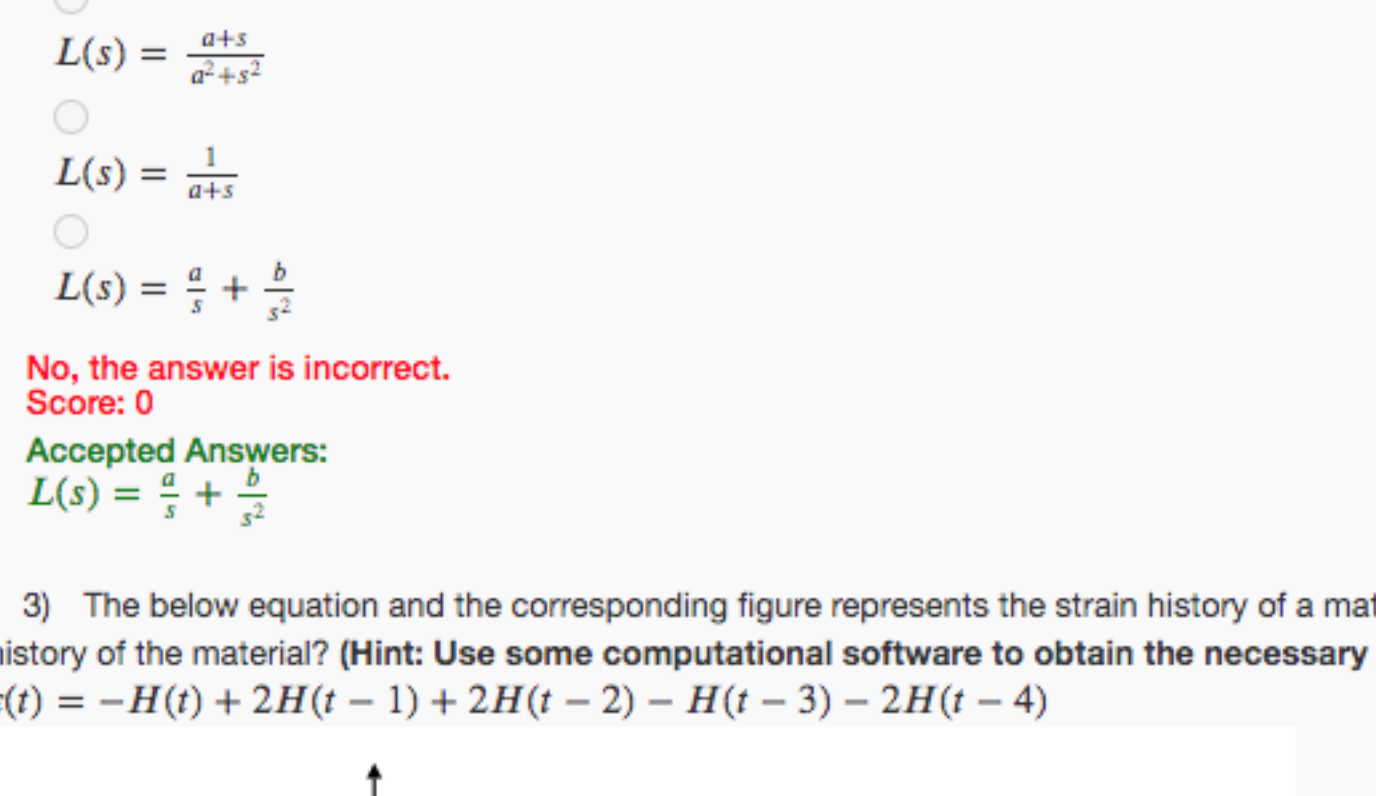
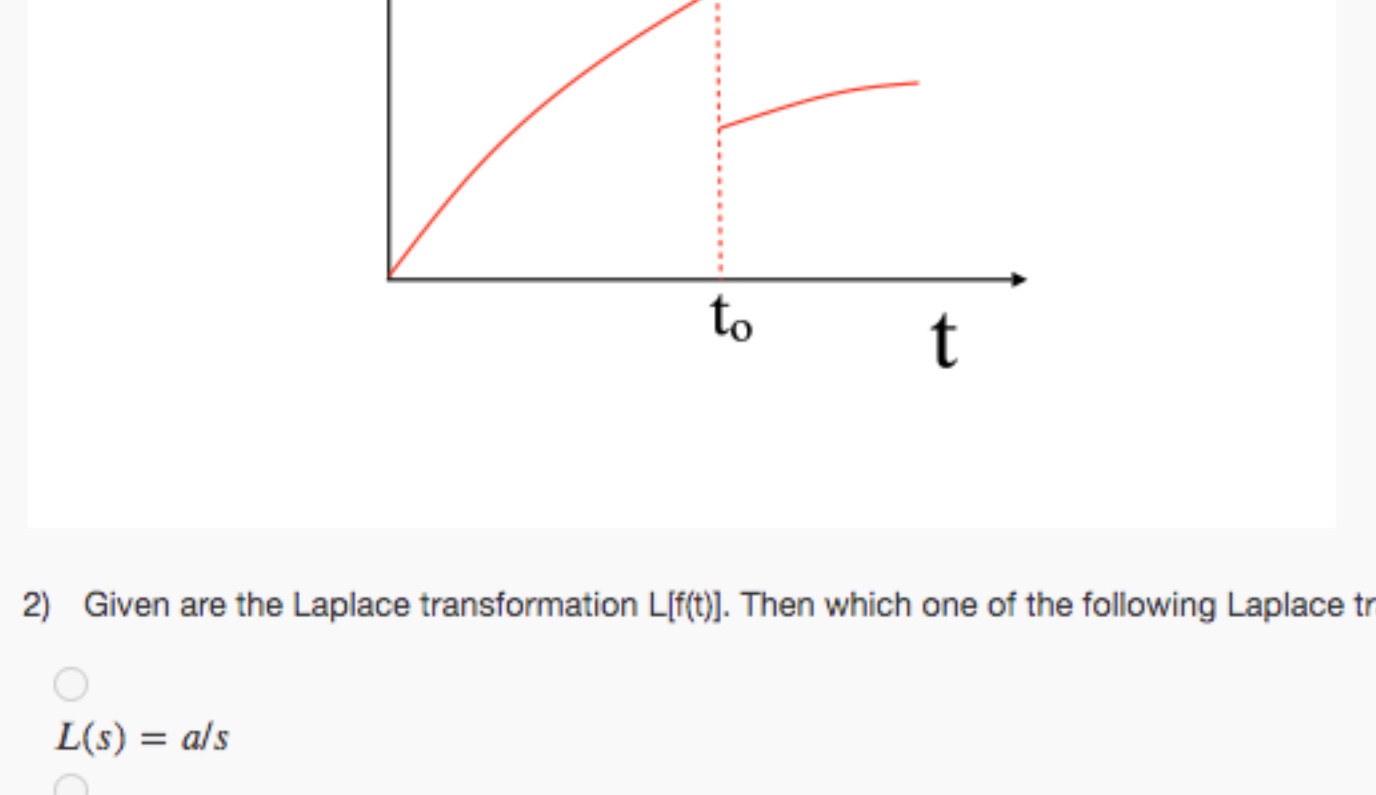
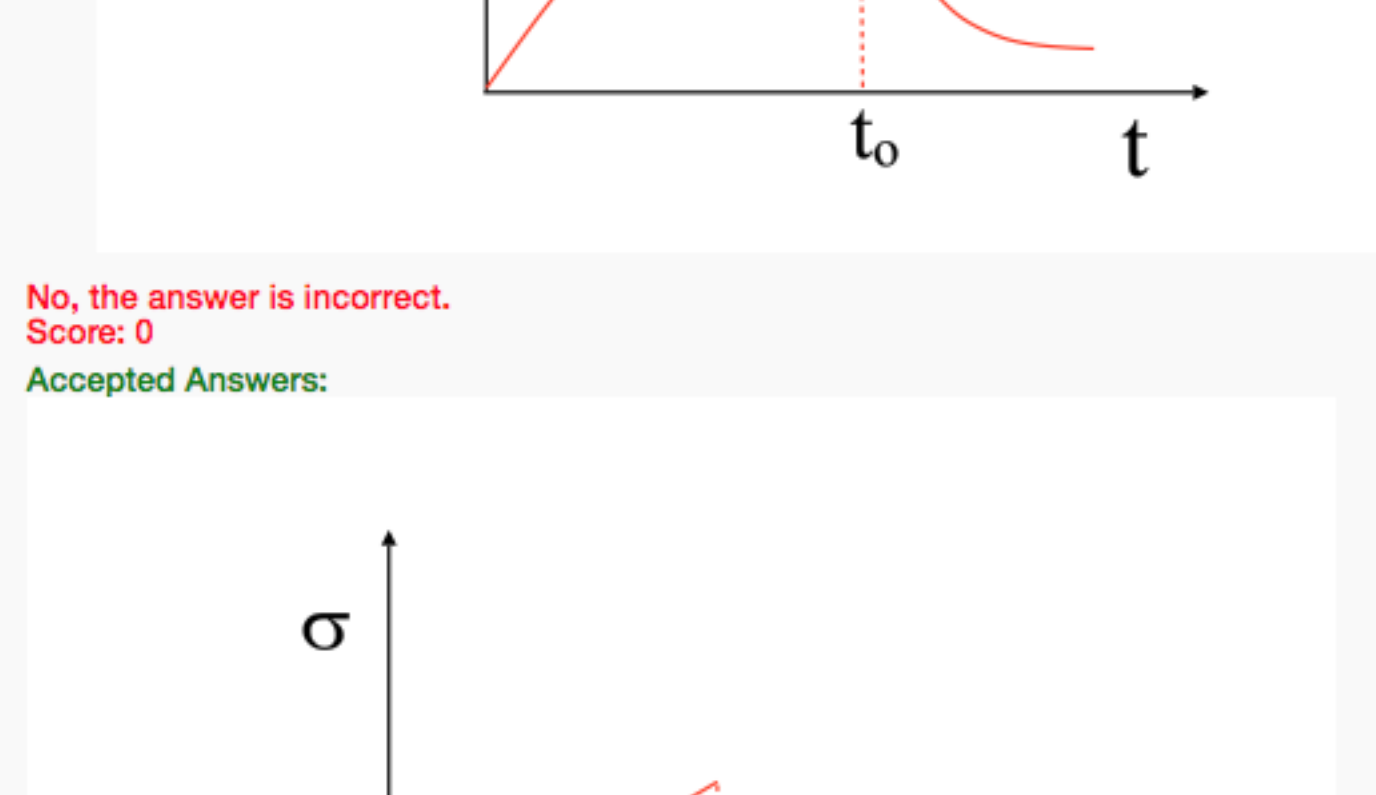
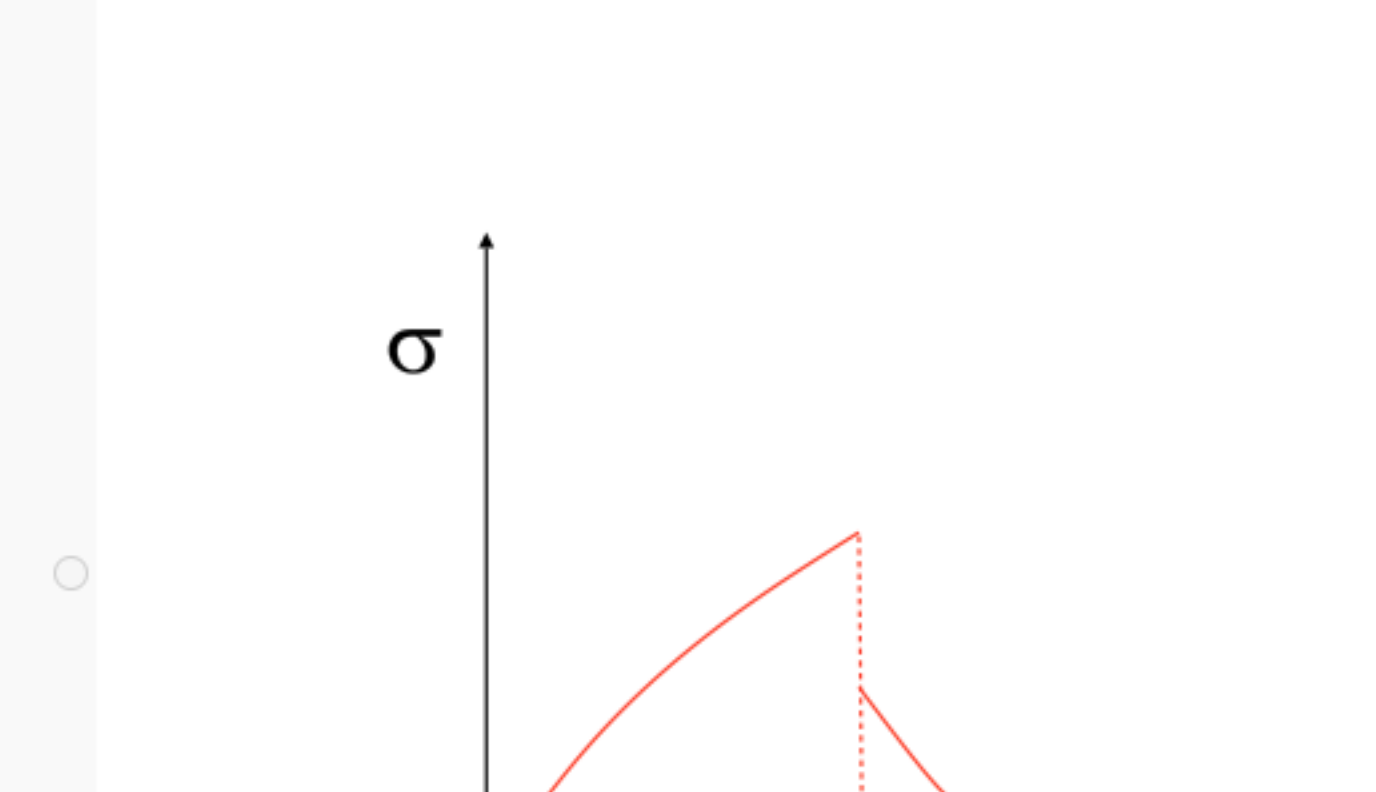
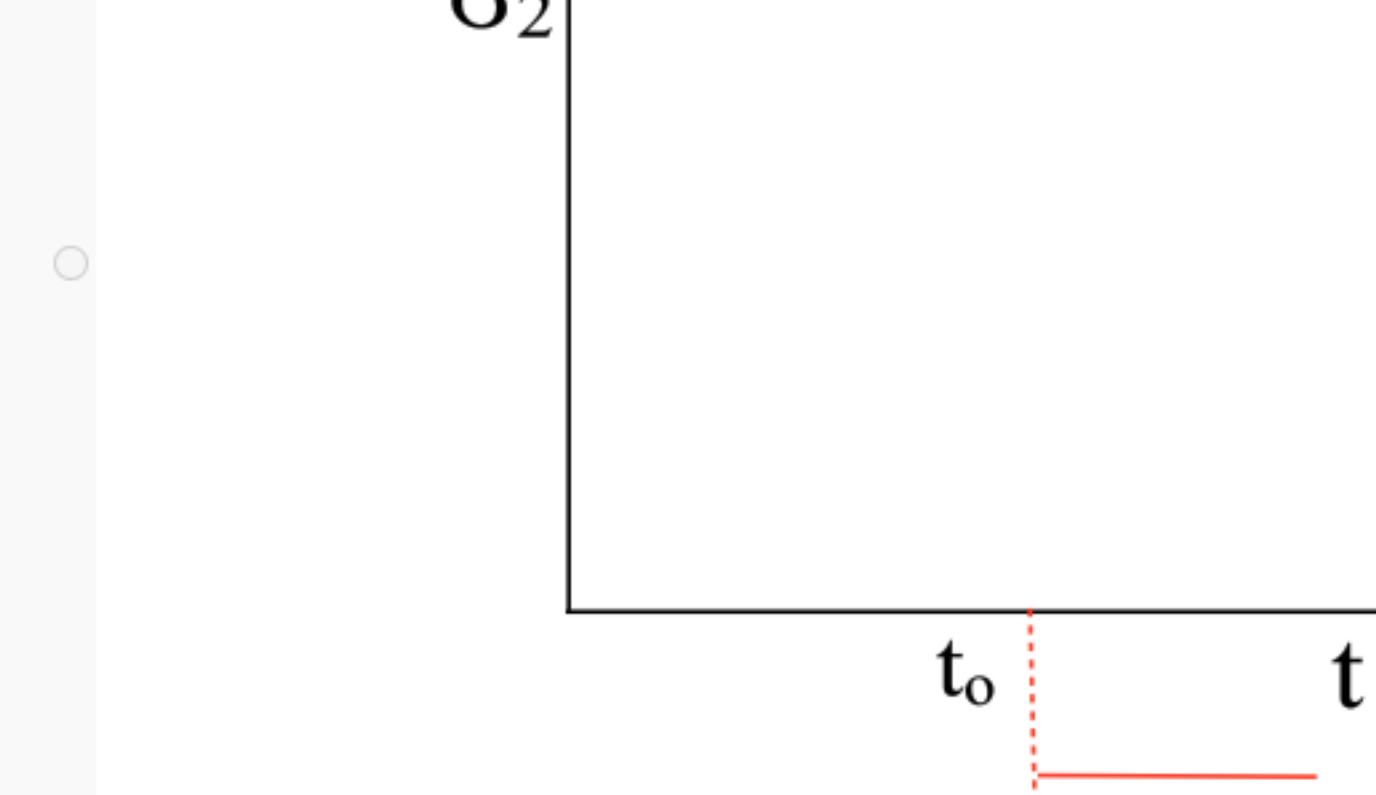
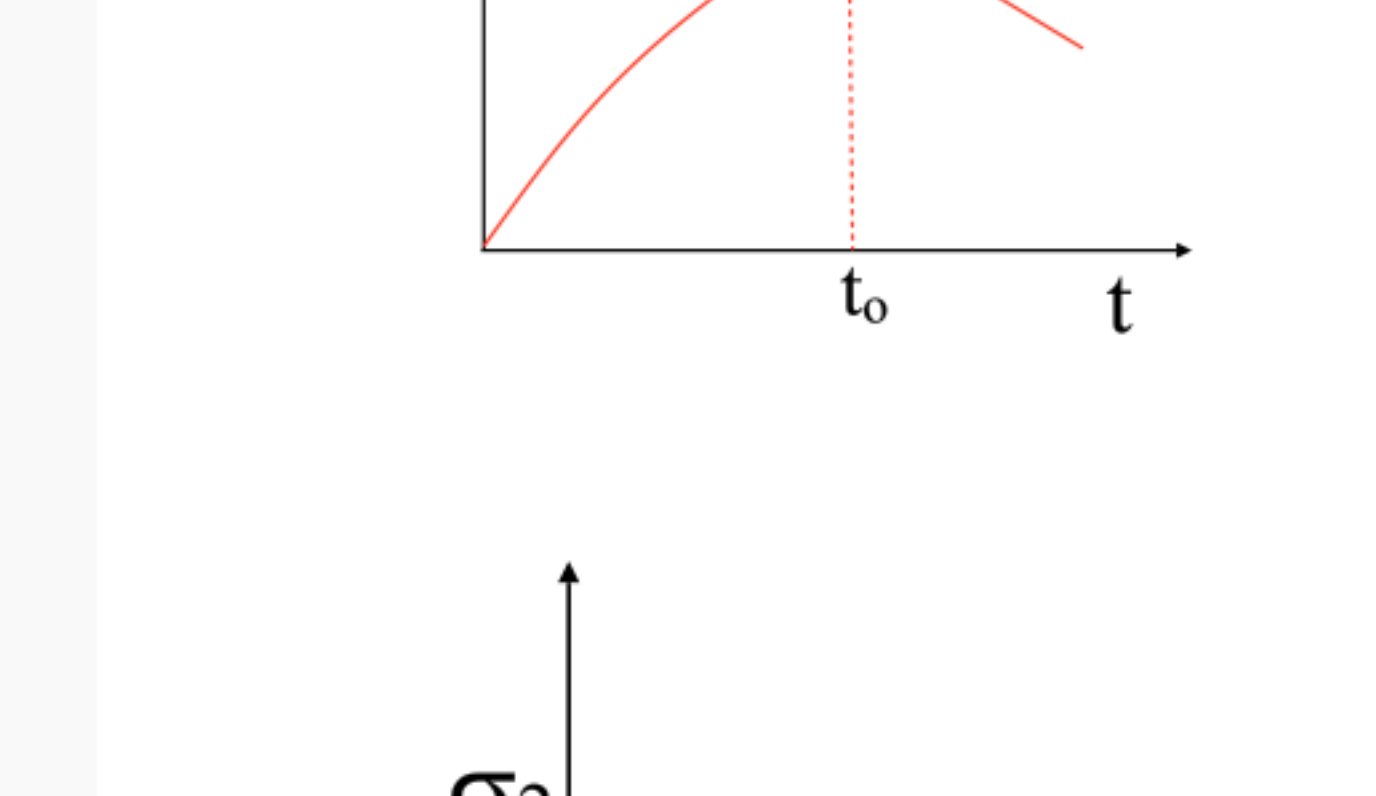
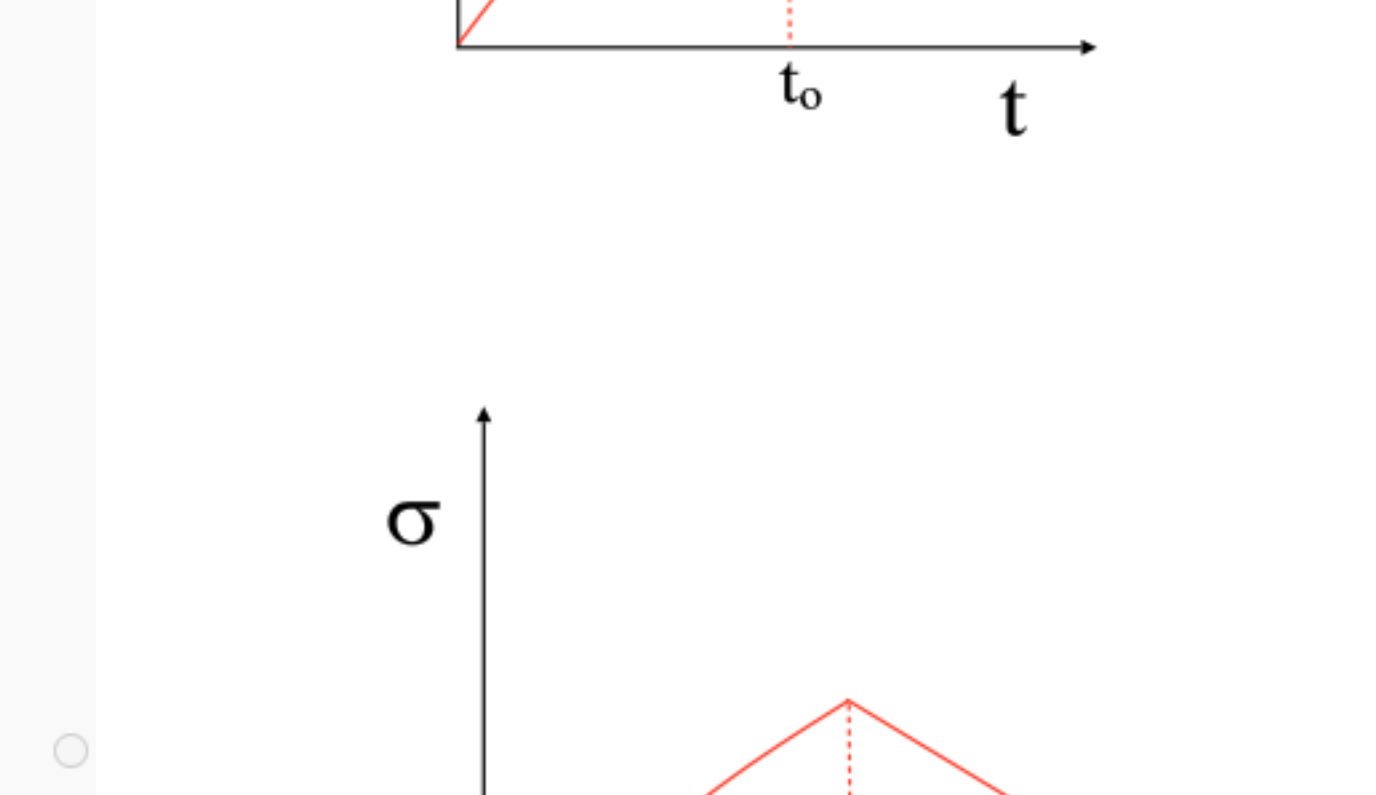
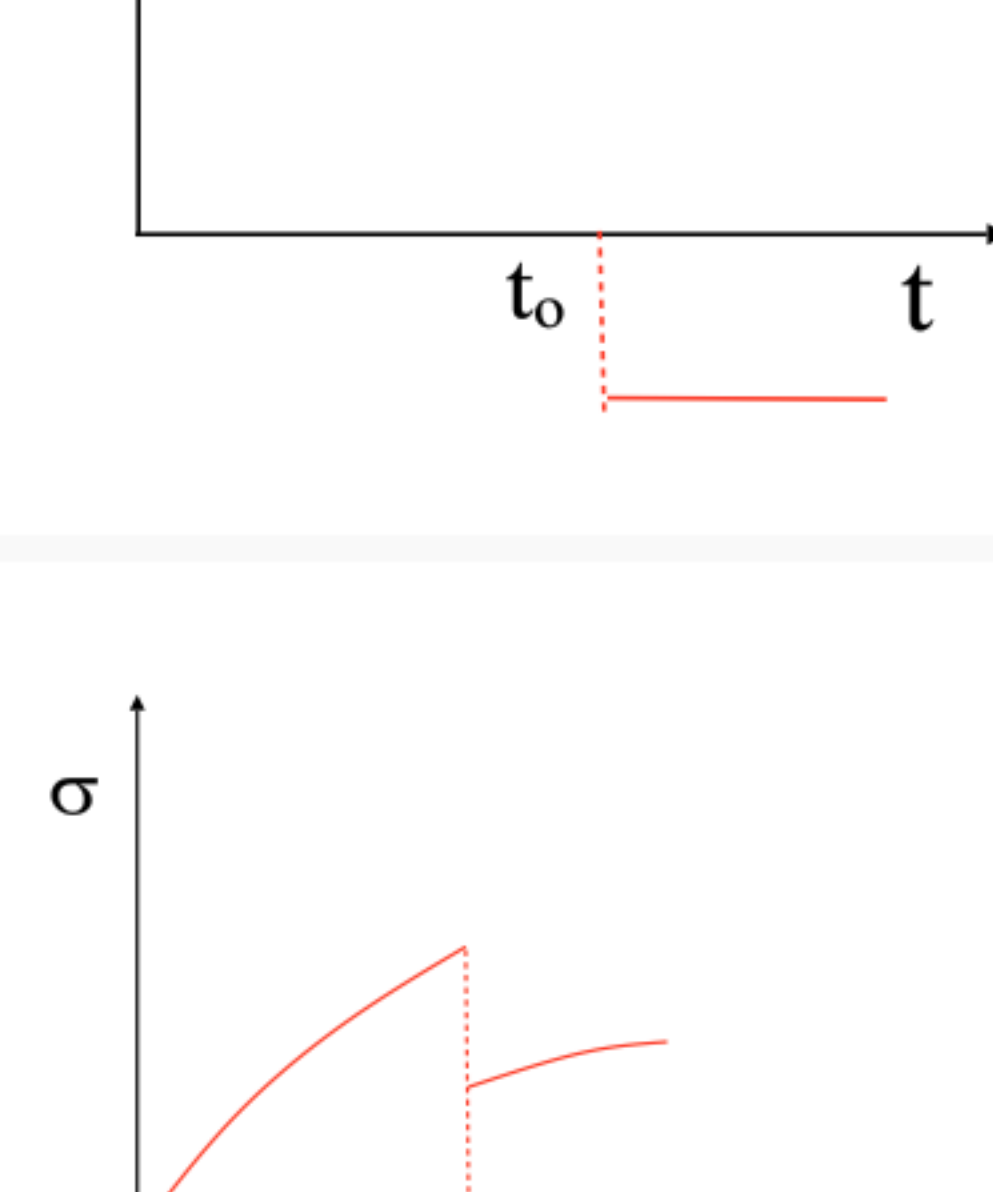
The due date for submitting this assignment has passed. As per our records you have not submitted this assignment.

**Due on 2020-03-11, 23:59 IST.**

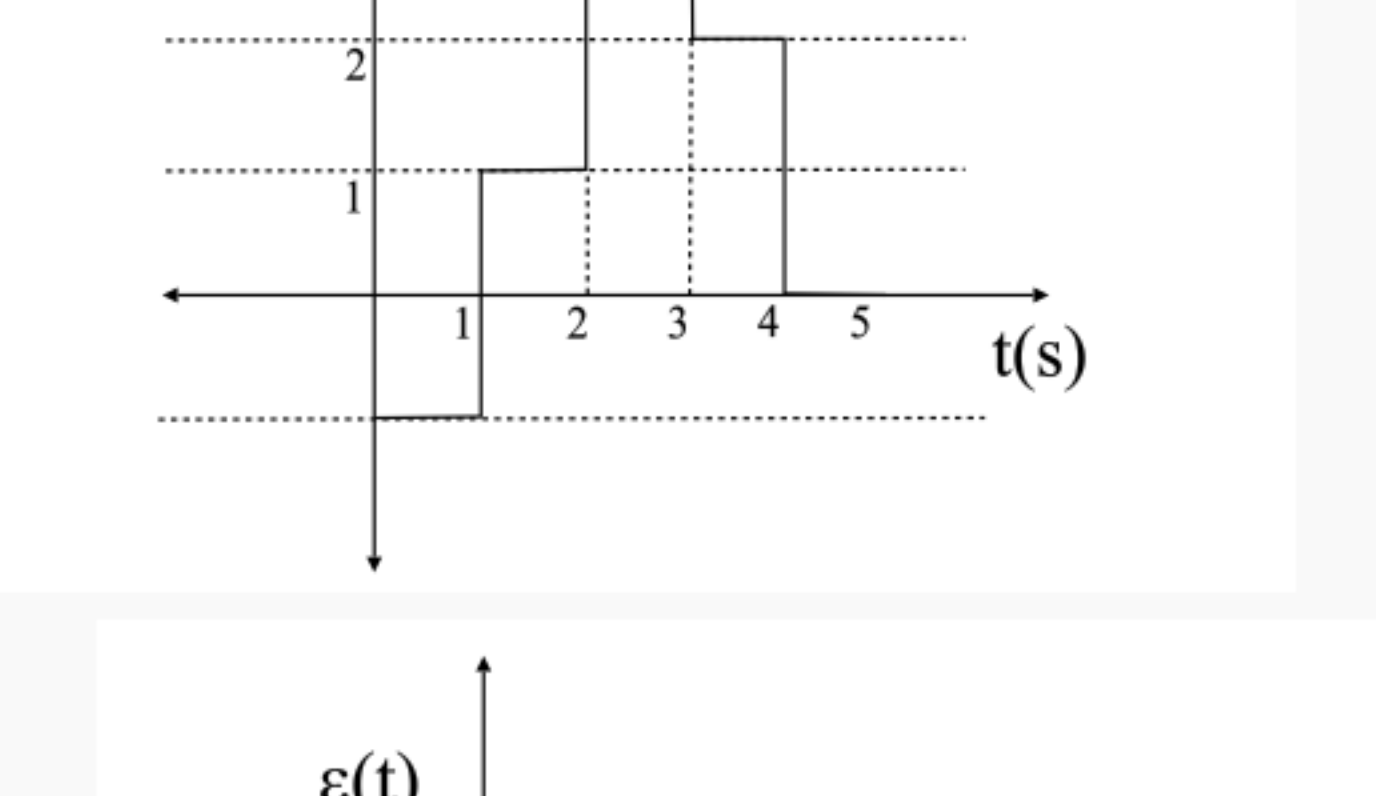
1) Consider the two stress inputs  $\sigma_1$  and  $\sigma_2$  shown in figure below. Which of the following figures represents superposition of  $\sigma_1$  and  $\sigma_2$ ? **1 point**



+



**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:



2) Given are the Laplace transformation  $L[f(t)]$ . Then which one of the following Laplace transform is obtained due to linear function of  $t$ ? **1 point**

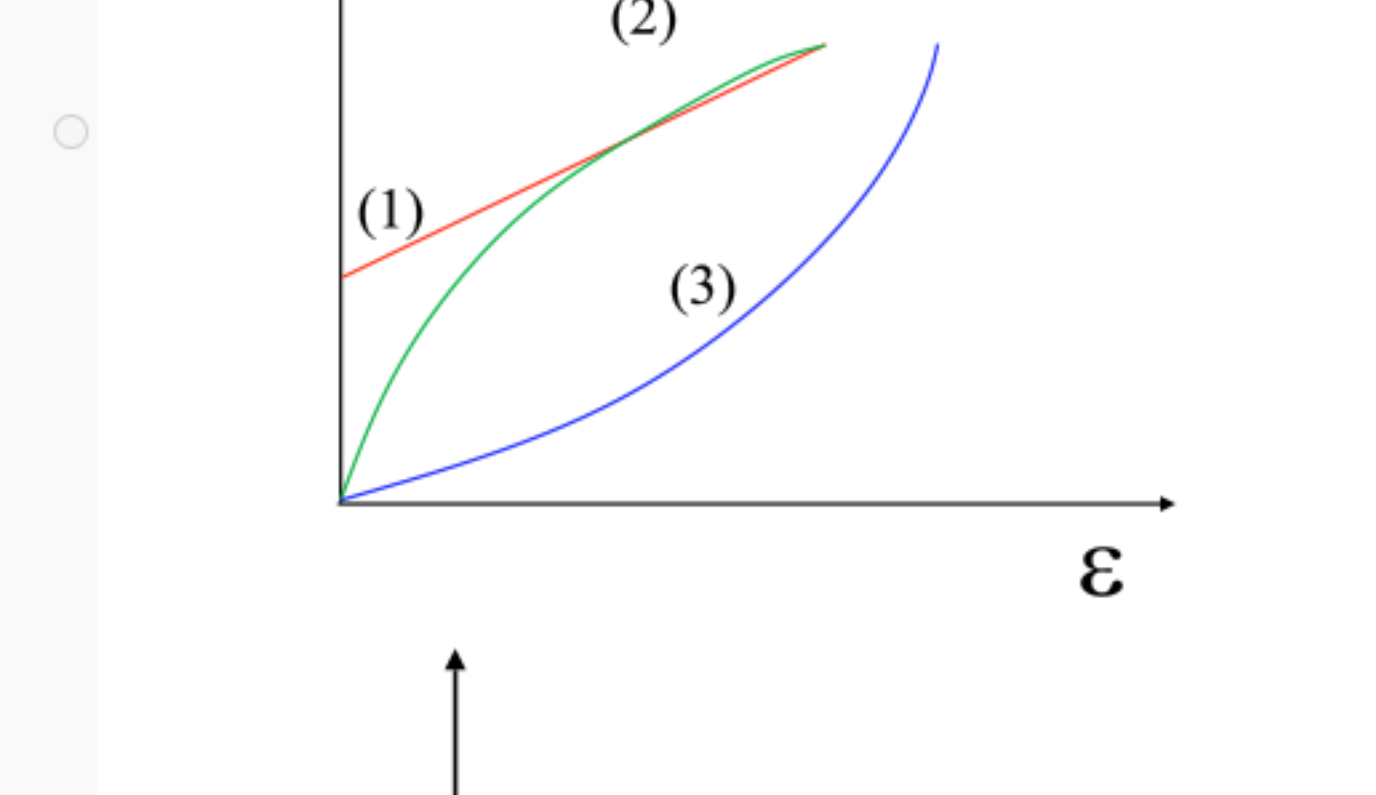
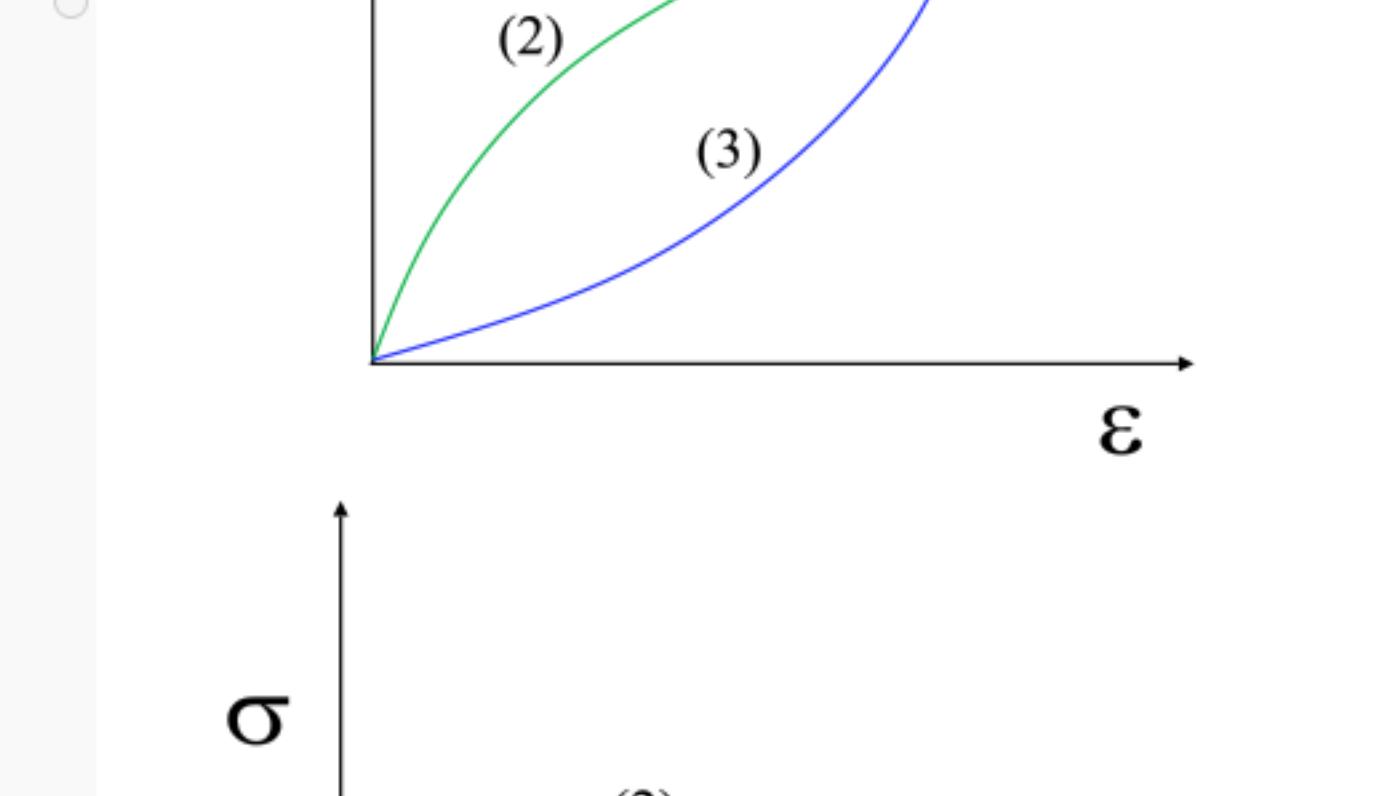
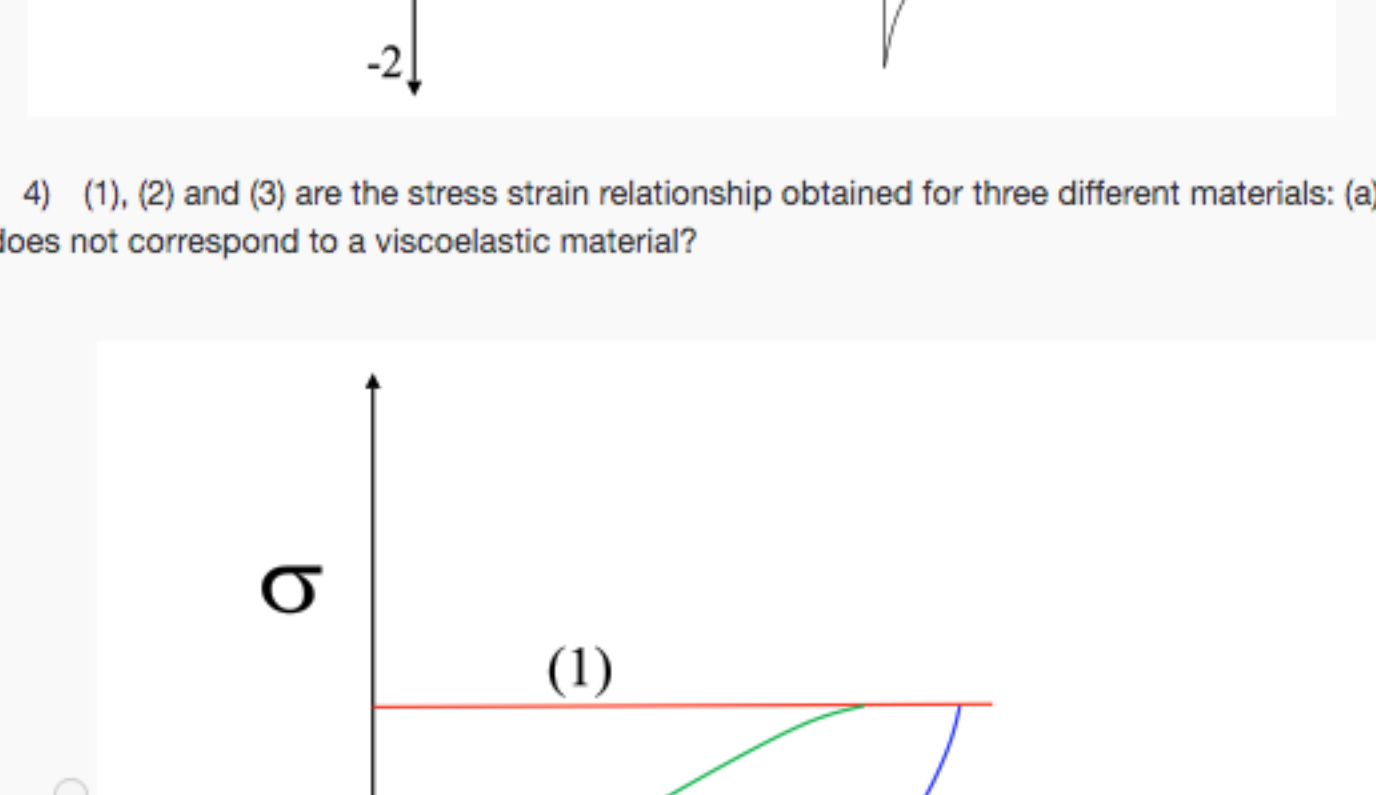
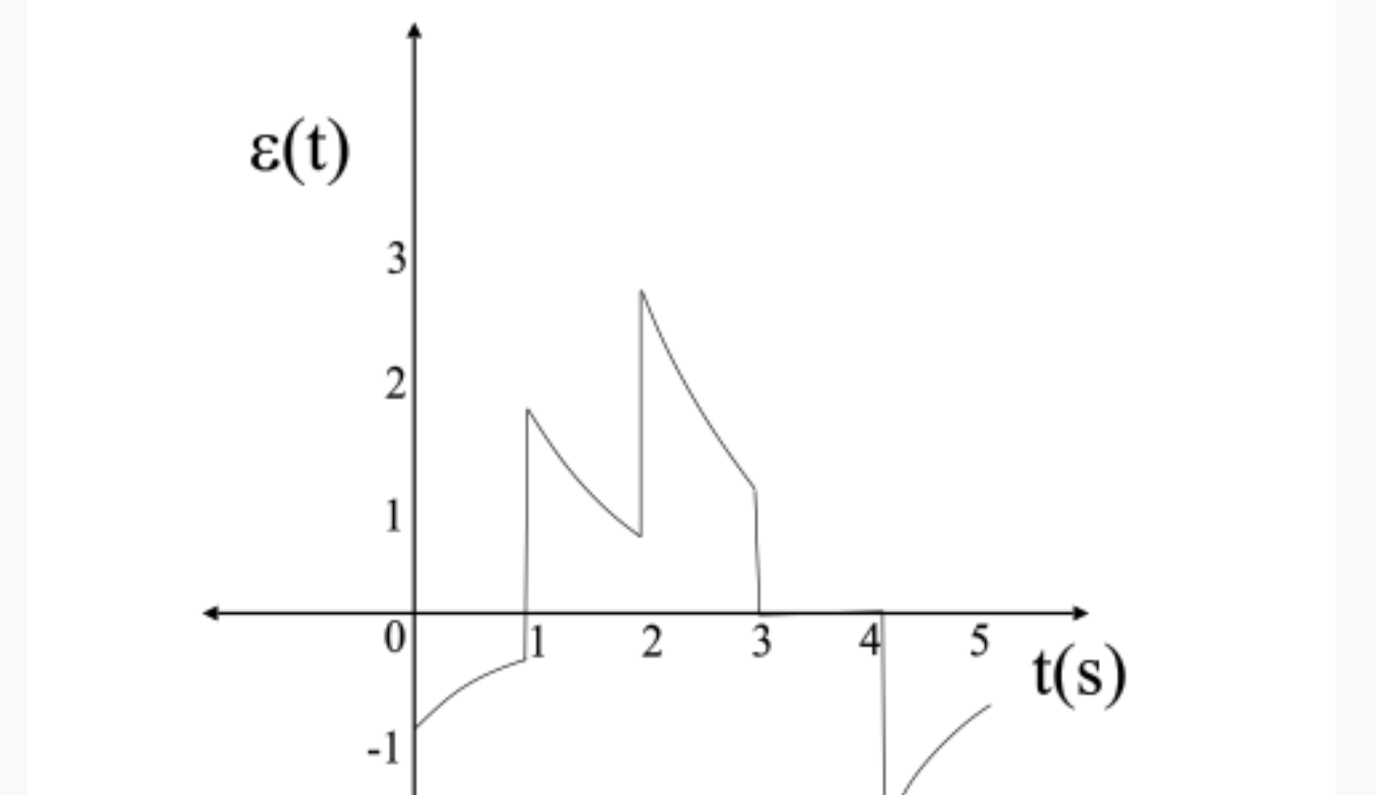
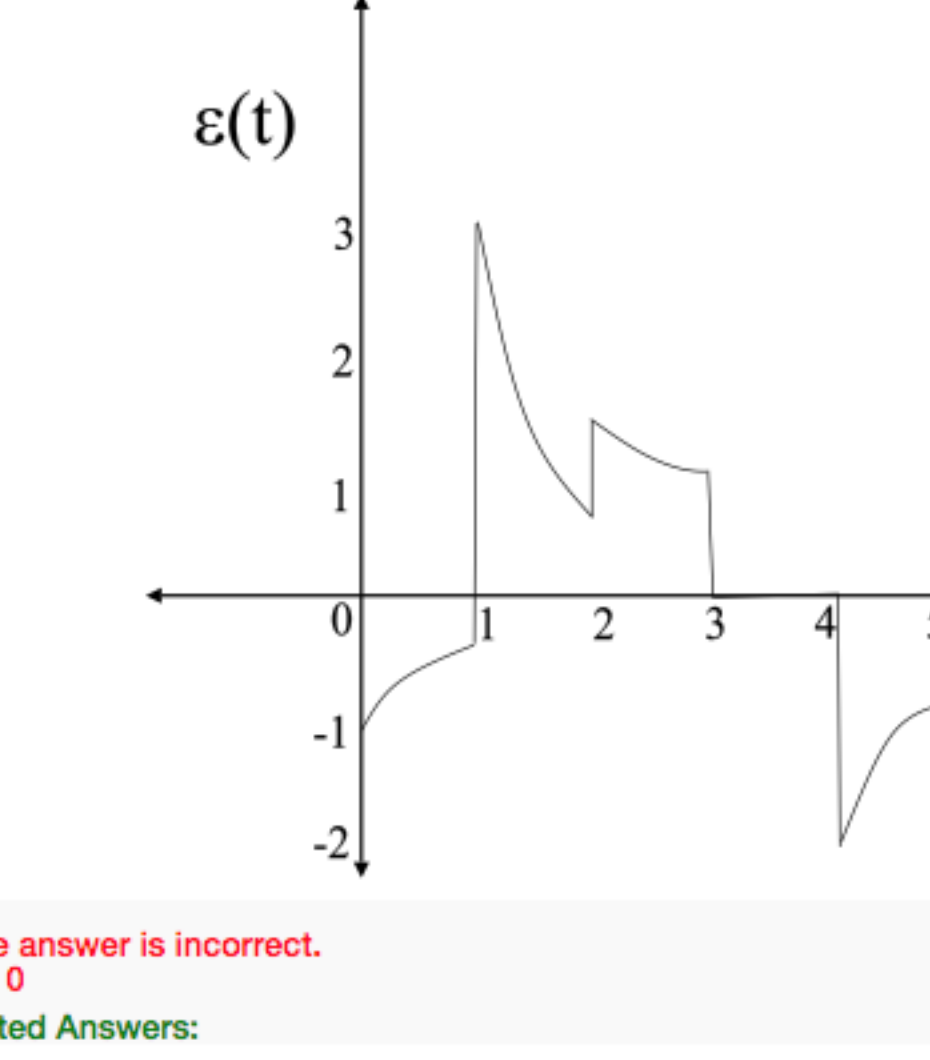
- $L(x) = a/x$
- $L(x) = \frac{a+x}{a^2+x^2}$
- $L(x) = \frac{1}{a+x}$
- $L(x) = \frac{a}{x} + \frac{b}{x^2}$

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

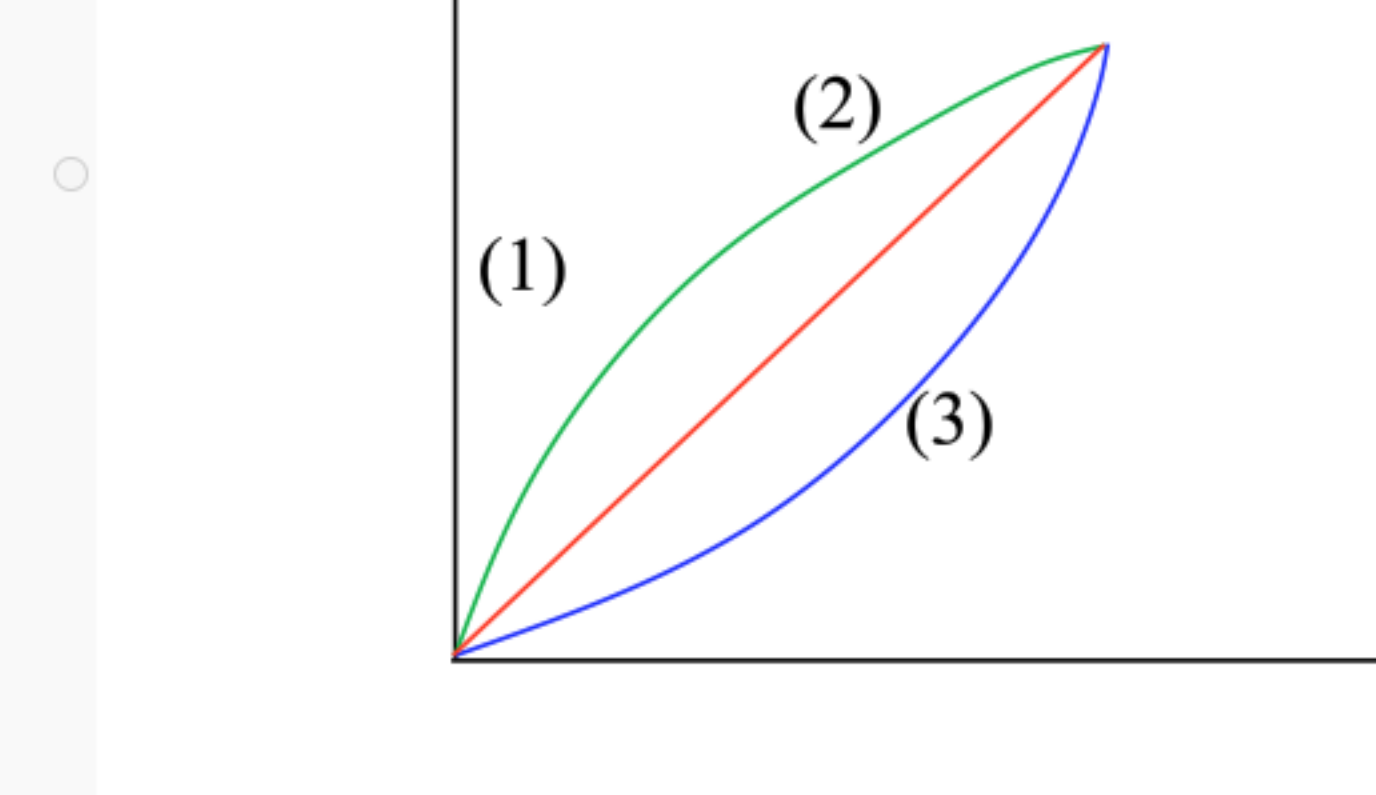
$L(x) = \frac{a}{x} + \frac{b}{x^2}$

3) The below equation and the corresponding figure represents the strain history of a material. Which of the following figures corresponds to the stress history of the material? (Hint: Use some computational software to obtain the necessary plot) **1 point**

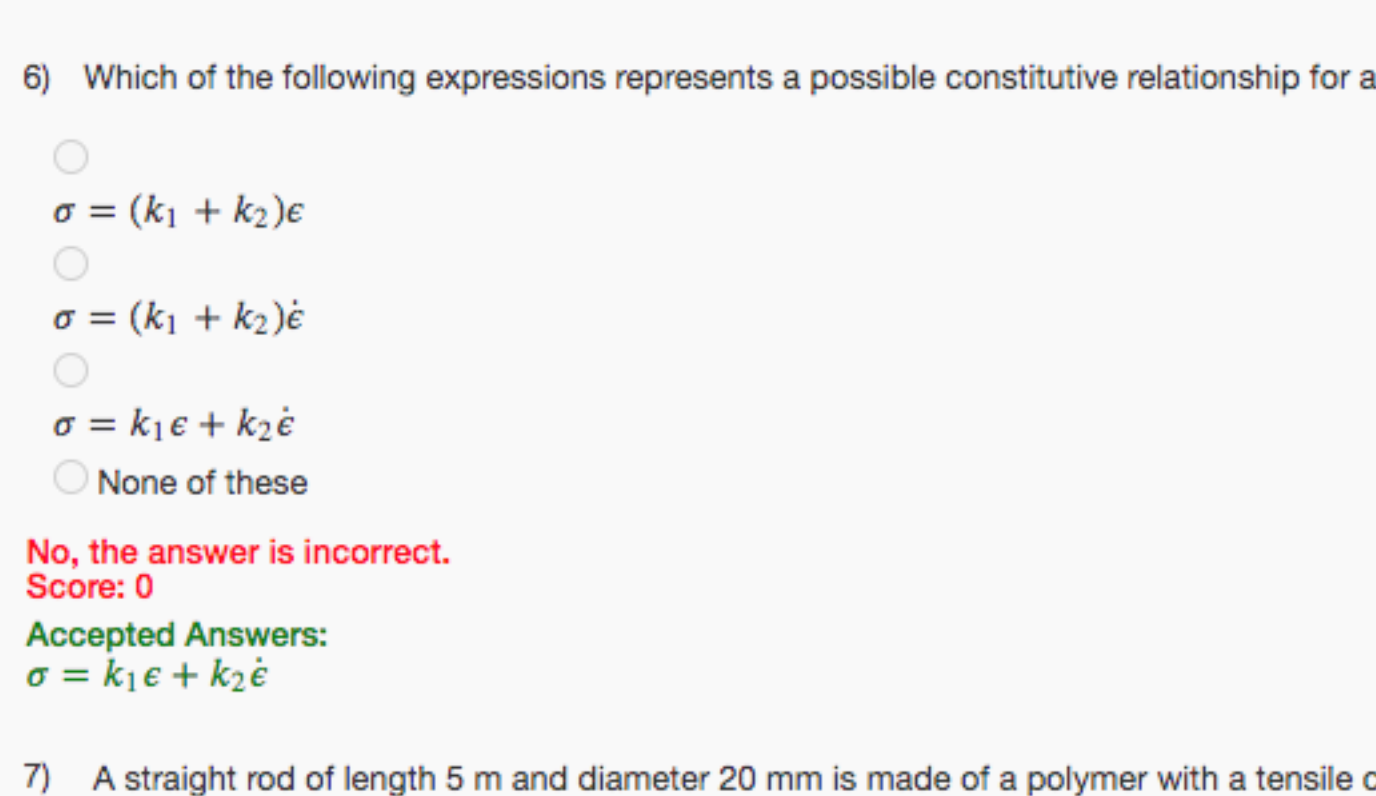
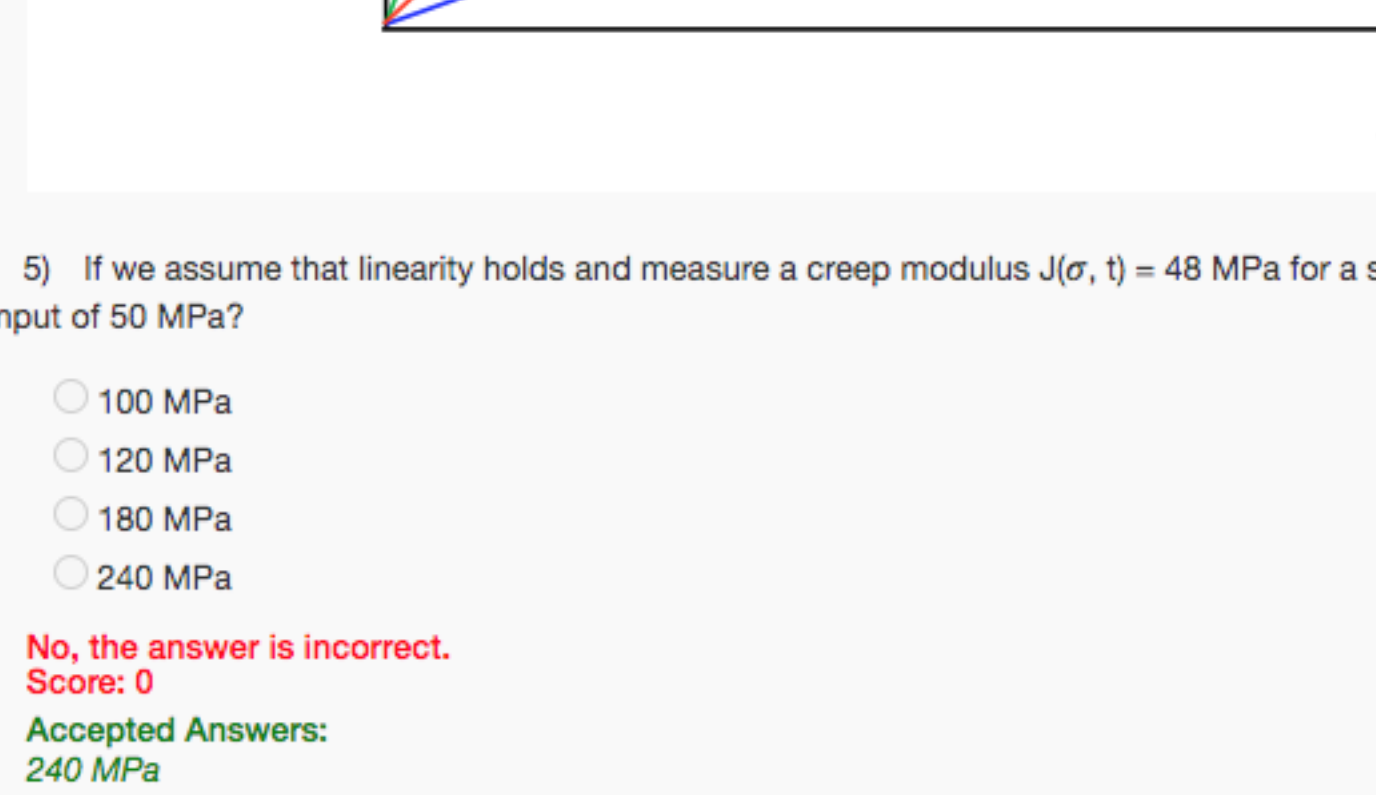
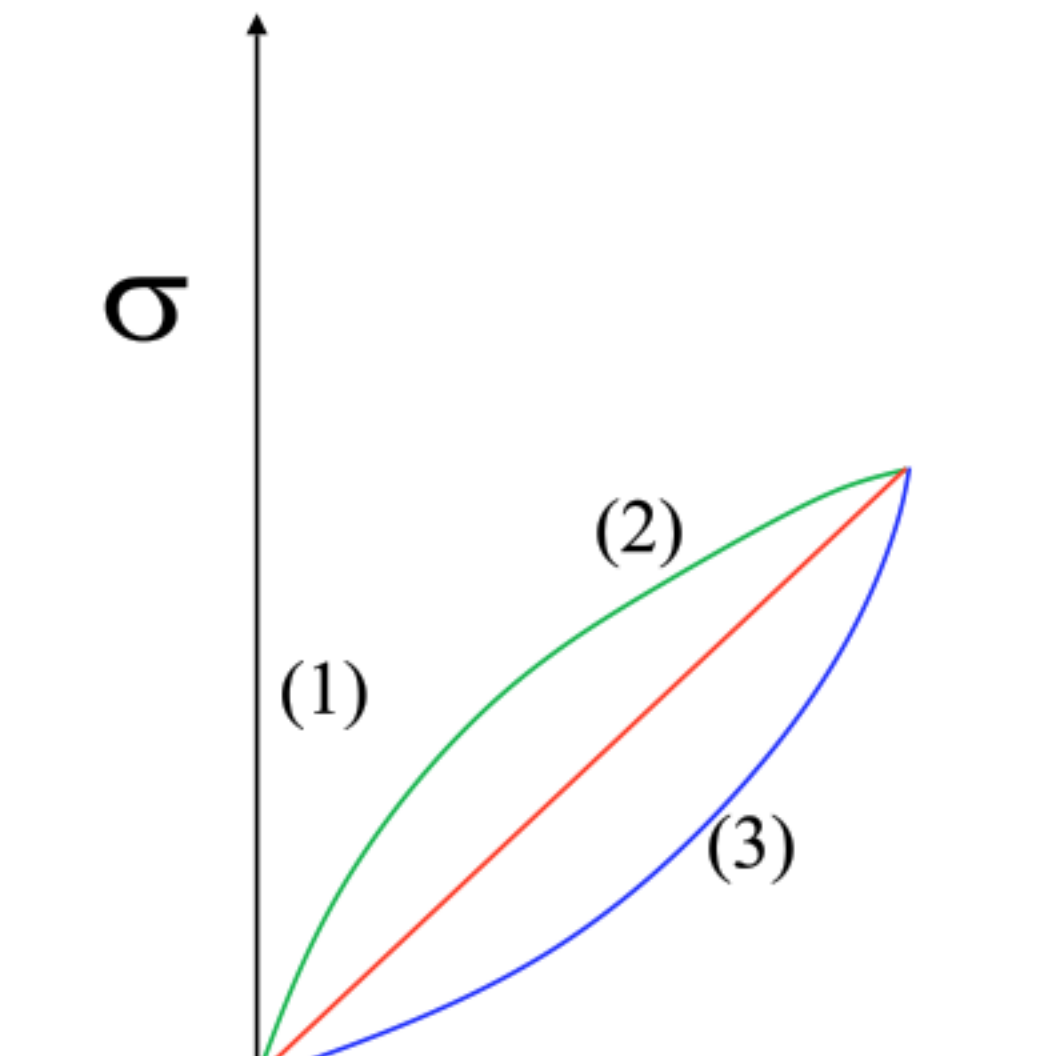
$\epsilon(t) = -H(t) + 2H(t-1) + 2H(t-2) - H(t-3) - 2H(t-4)$



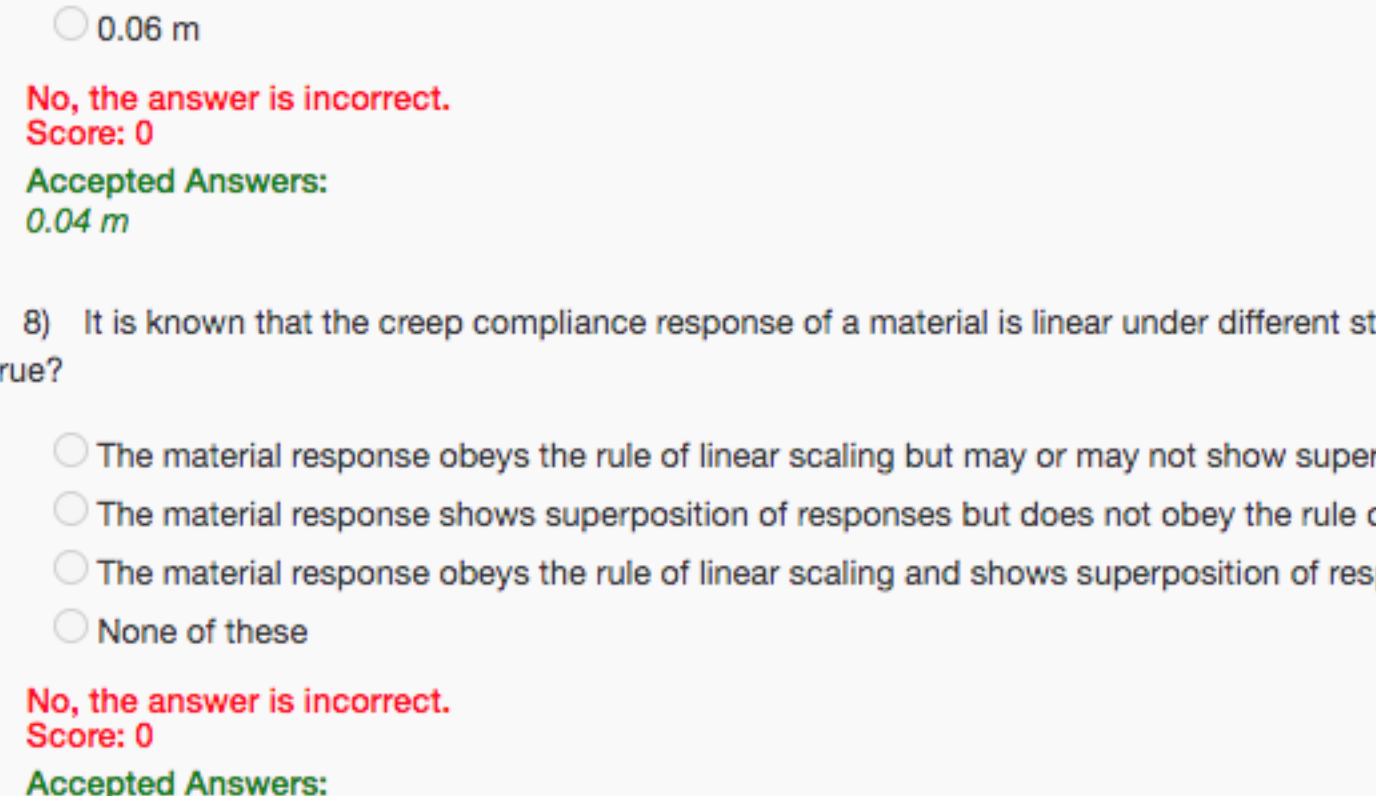
**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:



4) (1), (2) and (3) are the stress strain relationship obtained for three different materials: (a), (b) & (c). Then which of the following  $\sigma - \epsilon$  relationships does not correspond to a viscoelastic material? **1 point**



**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:



5) If we assume that linearity holds and measure a creep modulus  $J(\sigma, t) = 48$  MPa for a stress input of 10 MPa, then what is creep modulus for a stress input of 50 MPa? **1 point**

- 100 MPa
- 120 MPa
- 180 MPa
- 240 MPa

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

240 MPa

6) Which of the following expressions represents a possible constitutive relationship for a viscoelastic material? **1 point**

- $\sigma = (k_1 + k_2)\epsilon$
- $\sigma = (k_1 + k_2)\dot{\epsilon}$
- $\sigma = k_1\epsilon + k_2\dot{\epsilon}$
- None of these

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

$\sigma = k_1\epsilon + k_2\dot{\epsilon}$

7) A straight rod of length 5 m and diameter 20 mm is made of a polymer with a tensile creep compliance given by  $J(t) = 5 \times 10^{-12} GPa^{-1}$  where  $t$  is in hours. If the rod is suspended vertically and a mass of 50 kg is hung from it for 4 hours. What is the change in length of the rod? **1 point**

- 0.01 m
- 0.02 m
- 0.04 m
- 0.06 m

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

0.04 m

8) It is known that the creep compliance response of a material is linear under different stress inputs. Then which of the following statement must be true? **1 point**

- The material response obeys the rule of linear scaling but may or may not show superposition of responses.
- The material response shows superposition of responses but does not obey the rule of linear scaling.
- The material response obeys the rule of linear scaling and shows superposition of responses.
- None of these

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

The material response obeys the rule of linear scaling and shows superposition of responses.

9) A certain viscoelastic material has a stress response represented by the function  $\sigma(t) = 2t^2$ . If the  $\sigma - \epsilon$  relationship of the material is known and can be defined as  $\sigma = 5\epsilon + 3\frac{d\epsilon}{dt}$ , then which one of the following equations represents the correct relationship for the strain  $\epsilon(t)$  of the given material? Assume that the material does not have any strain initially at  $t = 0$ . **1 point**

- $\epsilon(t) = \frac{50t^2 - 30t + 36e^{-2t} - 36}{125e^{2t}}$
- $\epsilon(t) = \frac{50t^2 - 60t + 36e^{-2t} - 36}{125e^{2t}}$
- $\epsilon(t) = \frac{50t^2 - 60t + 36e^{2t} - 36}{125e^{2t}}$
- $\epsilon(t) = \frac{50t^2 - 60t + 18e^{-2t} - 18}{125e^{2t}}$

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

$\epsilon(t) = \frac{50t^2 - 60t + 36e^{2t} - 36}{125e^{2t}}$

10) If  $t_2 > t_1$ , then identify if the given plot is true or false: **1 point**



- True
- False

**No, the answer is incorrect.**  
Score: 0  
Accepted Answers:

False