Prob. 19.11- Load-unload stress cycle

Define step function *u(t)* using Heaviside function:

```
> u:=proc(t,a) Heaviside(t-a) end;
```

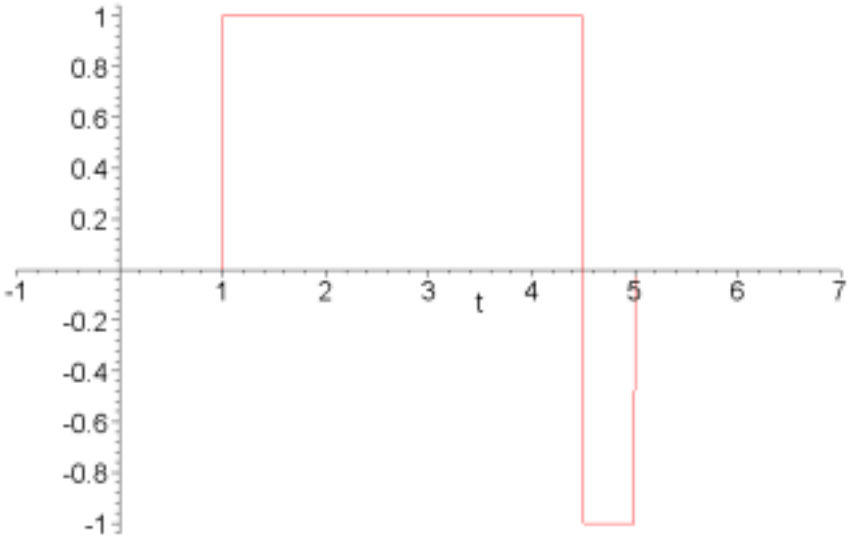
$$u := \mathbf{proc}(t, a)\ \text{Heaviside}(t - a)\ \mathbf{end}$$

Define stress history:

```
> sigma:= (t)-> 1*u(t,1)-2*u(t,4.5)+1*u(t,5);
```

$$\sigma := t \rightarrow \mathrm{u}(t, 1) - 2\,\mathrm{u}(t, 4.5) + \mathrm{u}(t, 5)$$

```
> plot(sigma(t),t=-1..7);
```



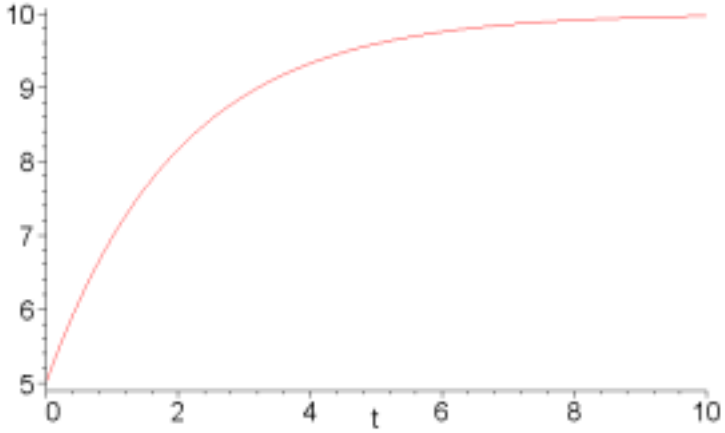
Define SLS creep compliance:

```
> C_crp:= (t)-> Cg+(Cr-Cg)*(1-exp(-t/tau));
```

$$C\_crp := t \rightarrow Cg + (Cr - Cg)\left(1 - \mathbf{e}^{\left(-\frac{t}{\tau}\right)}\right)$$

Examine compliance function with given parameters:

```
> Cg:=5:Cr:=10:tau:=2:
> plot(C_crp(t),t=0..10);
```

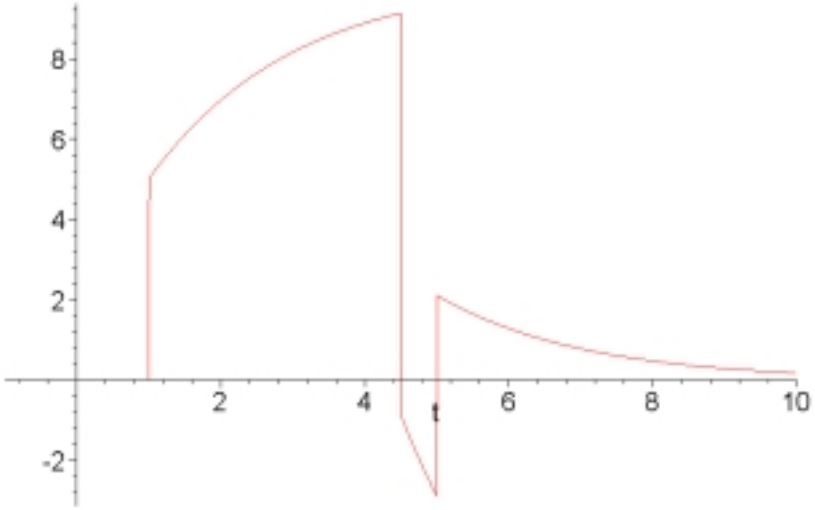


Superposition integral for strain history:

```
> epsilon:= (t)-> int(C_crp(t-xi)*diff(sigma(xi),xi),xi=-1..t);
```

$$\varepsilon := t \to \int_{-1}^{t} \mathrm{C\_crp}(t-\xi)\left(\frac{\partial}{\partial \xi}\sigma(\xi)\right) d\xi$$

```
> plot(epsilon(t),t=-1..10);
```



Note that for this particular case the strain after t=5 rises above zero even though all the stress has been removed - a consequence of the material's memory of the long tensile stress preceding the short compressive stress.
