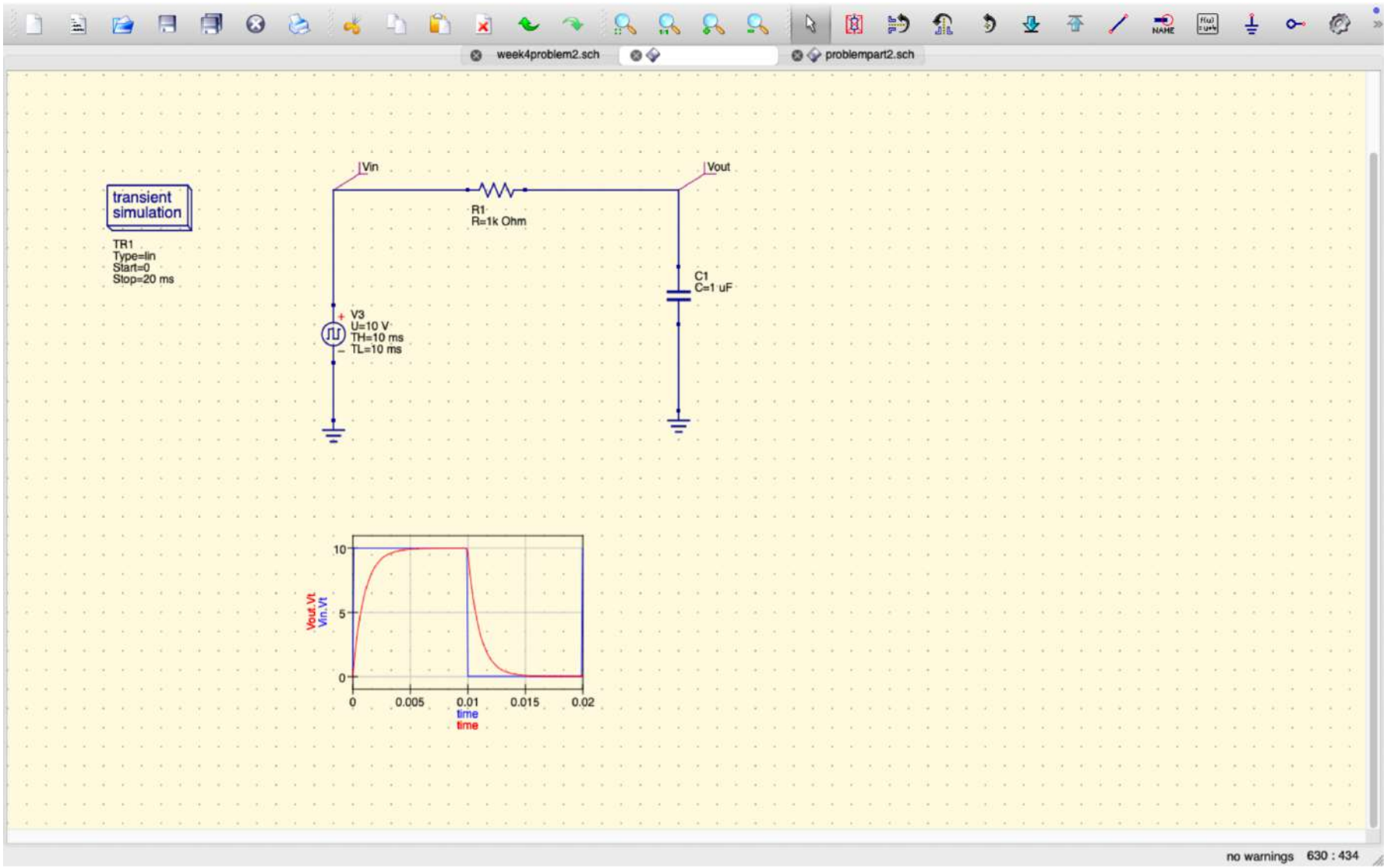
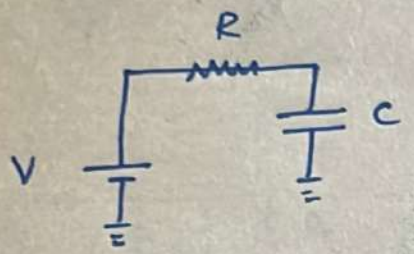
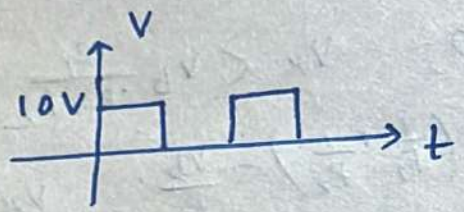

week4problem2.sch
problempart2.sch
transient simulation
TR1
Type=lin
Start=0
Stop=20 ms
Vin
Vout
R1
R=1k Ohm
C1
C=1 uF
V3
U=10 V
TH=10 ms
TL=10 ms
10
5
0
0
0.005
0.01
0.015
0.02
time
time
Vout.Vt
Vin.Vt
no warnings
630 : 434

(1) (a)





$T >>> RC$

(i)

$$V_c = V_{ss} + (V_0 - V_{ss}) \exp\left(\frac{-t}{RC}\right)$$

$$V_c = 10 + (-10) \exp\left(\frac{-t}{RC}\right)$$

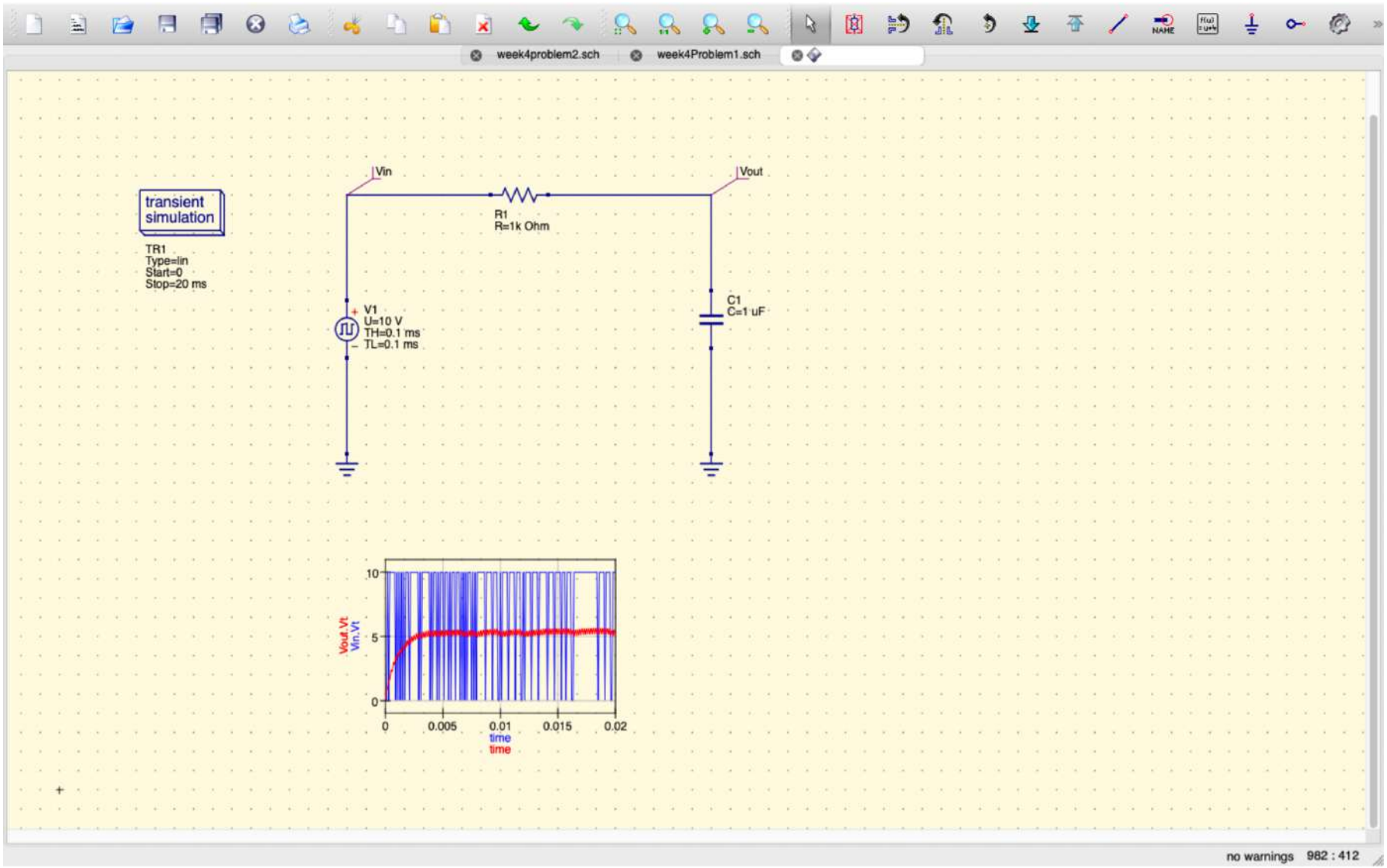
$$V_c = 10 \left\{ 1 - \exp\left(\frac{-t}{RC}\right) \right\}.$$

(ii) Negative half cycle :-

$$V_c = V_{ss} + (V_0 - V_{ss}) \exp\left(\frac{-t}{RC}\right)$$

$$V_c = 0 + (10 - 0) \exp\left(\frac{-t}{RC}\right)$$

$$V_c = 10 \exp\left(\frac{-t}{RC}\right)$$


week4problem2.sch
week4Problem1.sch
transient simulation
TR1
Type=lin
Start=0
Stop=20 ms
Vin
Vout
R1
R=1k Ohm
V1
U=10 V
TH=0.1 ms
TL=0.1 ms
C1
C=1 uF
10
5
0
Vout.Vt
Vin.Vt
0
0.005
0.01
0.015
0.02
time
time
no warnings
982 : 412

(b) $T \ll RC$:-

$V_c = 10\left(1-\exp\left(\frac{-T}{2RC}\right)\right)$ } 1st half cycle.

$V_c = 10\left(1-\exp\left(\frac{-T}{2RC}\right)\right)\exp\left(\frac{-T}{2RC}\right)$ } first cycle.

$V_c = 10\left(1-\exp\left(\frac{-T}{2RC}\right)\right) + 10\left(1-\exp\left(\frac{-T}{2RC}\right)\right)\exp\left(\frac{-T}{2RC}\right)\cdot\exp\left(\frac{-T}{2RC}\right)$.

$\exp\left(\frac{-T}{2RC}\right) = x$.

$V_c = 10(1-x) + 10(1-x)(x^2)$

$V_c = 10(1-x) + 10(x^2-x^3)$

$V_c = 10(1-x+x^2-x^3)$. } 1.5 cycle

$V_c = 10(1-x+x^2-x^3+x^4-x^5)$ } 2.5 cycle.

$V_c = 10(1-x+x^2-x^3+x^4-x^5+\cdots)$ } till ∞ cycles

$|x| < 1$

$(x) = -x$

$$V_c = \frac{10\,(1)}{1-(-x)}$$

$$V_c = \left(\frac{10}{1+x}\right)$$

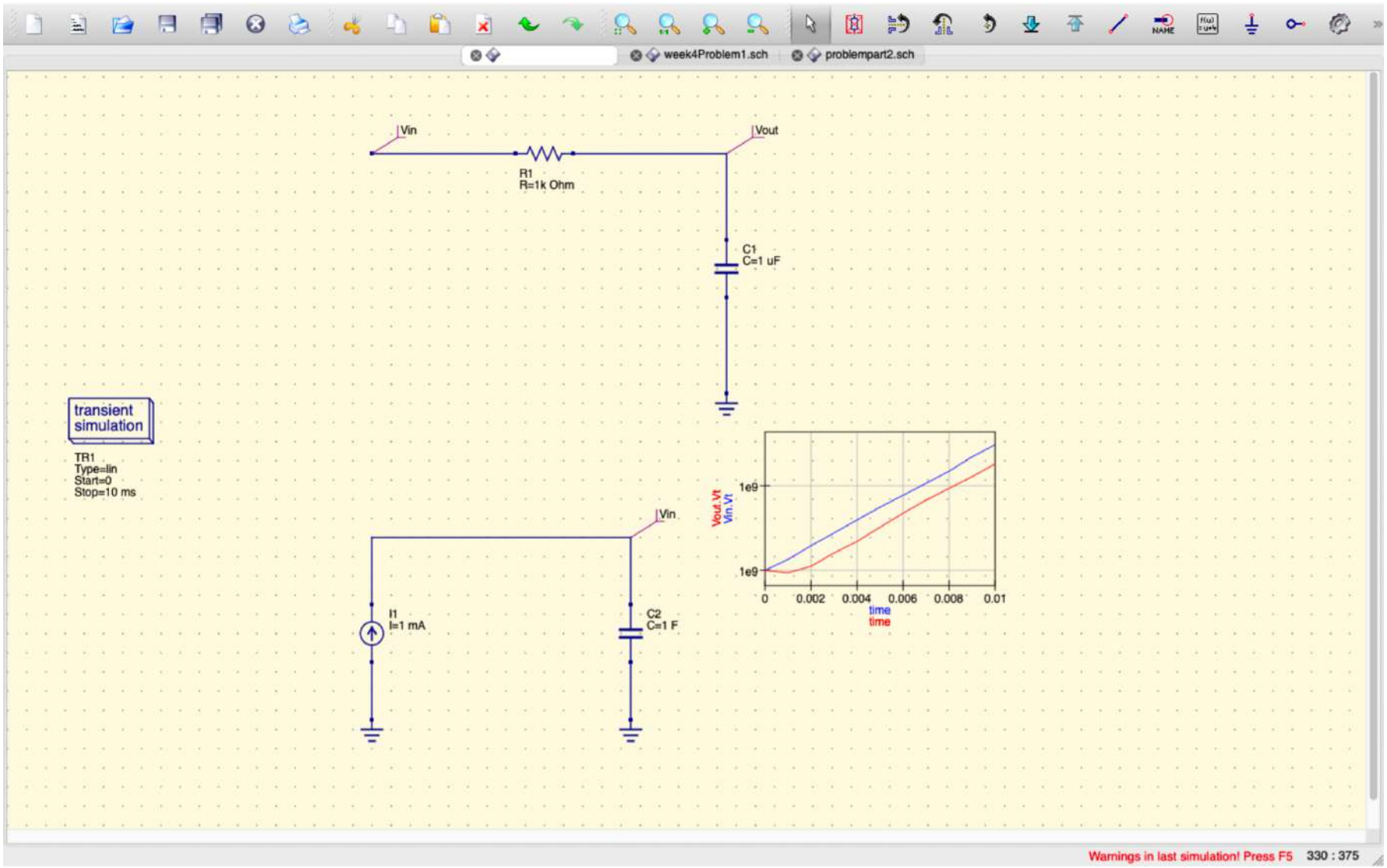
$$V_c = \frac{10}{1+\exp\left(\frac{-T}{2RC}\right)}$$

$$V_c = \frac{10}{2} \Rightarrow 5\,//$$

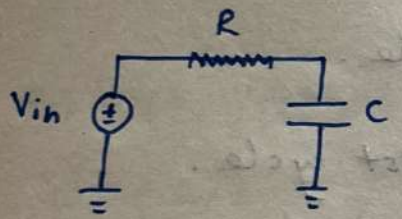
$$\exp\left(\frac{-T}{2RC}\right) = 1-\left(\frac{T/2}{RC}\right) + \frac{(T/2)^2}{2!RC} - \cdots$$

$$\underline{\exp\left(-\frac{T}{2RC}\right) \simeq 1}\,.$$

$$\underline{V_c = 5V}\,.$$


week4Problem1.sch
problempart2.sch
Vin
Vout
R1
R=1k Ohm
C1
C=1 uF
transient
simulation
TR1
Type=lin
Start=0
Stop=10 ms
Vin
I1
I=1 mA
C2
C=1 F
Vout.Vt
Vin.Vt
1e9
1e9
0
0.002
0.004
0.006
0.008
0.01
time
time
Warnings in last simulation! Press F5
330 : 375

(2)



$V_{in} = t\,u(t)$

$V_{in}(s) = \left(\frac{1}{s^2}\right)$.

$$H(s) = \left(\frac{\frac{1}{sC}}{\frac{1}{sC} + R}\right)$$

$$H(s) = \left(\frac{1}{1 + sRC}\right)$$

$$V_{out}(s) = \frac{1}{(1+sRC)\,s^2}$$

$$V_{out}(s) = \frac{1 - sRC}{s^2} - \frac{R^2C^2}{1+sRC}$$

$RC = 2$

$$V_{out}(s) = \frac{(1 - s2)}{s^2} - \frac{2^2}{(2s+1)}$$

$$V_{out}(s) = \left(\frac{1}{s^2}\right) - \left(\frac{2}{s}\right) - \frac{2}{\left(s + \frac{1}{2}\right)}.$$

$$V_{out}(t) = t\,u(t) - \tau\,u(t) - \tau \exp\left(\frac{-t}{\tau}\right)$$

$$V_{out}(t) = u(t)\left\{ t - \tau\left(1 - \exp\left(\frac{-t}{\tau}\right)\right)\right\}.$$

$$V_{out}(t) = u(t)\left\{ t - RC\left(1 - \exp\left(\frac{-t}{RC}\right)\right)\right\}.$$

Expected output :-

$V_{out}(t \to \infty) \Rightarrow (t - RC)$