IPhO 2016
International
Physics Olympiad
Switzerland
Liechtenstein

Theory
English (Official)

A2-1

Nonlinear Dynamics in Electric Circuits (10 points)

Part A. Stationary states and instabilities (3 points)

A.1 (0.4 pt)

$R_{\mathrm{on}} =$

$R_{\mathrm{off}} =$

$I_0 =$

$R_{\mathrm{int}} =$

A.2 (1 pt)

Possible numbers of stationary states for $R = 3.00\,\Omega$:

Possible numbers of stationary states for $R = 1.00\,\Omega$:

A.3 (0.6 pt)

$I_{\mathrm{stationary}} =$

$V_{\mathrm{stationary}} =$

A.4 $(1\,\mathrm{pt})$

Behaviour for $I(t=0) > I_{\mathrm{stationary}}$:

Behaviour for $I(t=0) < I_{\mathrm{stationary}}$:

Is the stationary state: □ stable? □ unstable?

Part B. Bistable non-linear elements in physics: radio transmitter (5 points)

B.1 (1.8 pt)

Justification:

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B.2 $(1.9 \, \text{pt})$

Formula of $t_1 =$

Numerical value of $t_1 =$

Formula of $t_2 =$

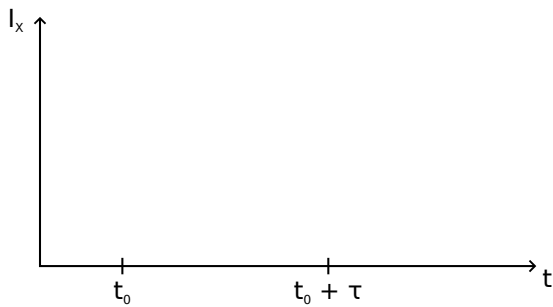Numerical value of $t_2 =$

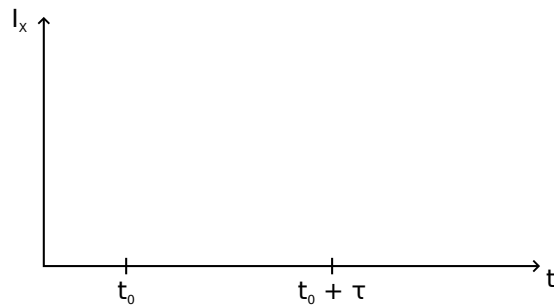Numerical value of $T =$

B.3 $(0.7 \, \text{pt})$

$P \approx$

B.4 $(0.6 \, \text{pt})$

$s =$

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Part C. Bistable non-linear elements in biology: neuristor (2 points)

C.1 (1.2 pt)
Sketch for $\tau < \tau_{\mathrm{crit}}$:

I_x

t_0 $t_0 + \tau$ t

Sketch for $\tau > \tau_{\mathrm{crit}}$:

I_x

t_0 $t_0 + \tau$ t

C.2 (0.6 pt)

Formula of $\tau_{\mathrm{crit}} =$

Numerical value of $\tau_{\mathrm{crit}} =$

C.3 (0.2 pt)

Is the circuit a neuristor? ☐ Yes ☐ No