ELEC2070 2023
Workshop Questions – Week 5
Capacitors, Inductors, Transient Response

Solve the following questions in your logbook manually using your own calculator to get used to hand written assessments. You can discuss the methods with other students and tutors but it is important to do the solutions yourself. These questions are from the text book [1]. Short answers are provided either in the book or here. A few solutions provided in the textbook are wrong. In these cases, the solutions provided here should be the correct ones.

You should solve at the very minimum one question from each section (Roman headings) but you are strongly advised to complete all questions. Doing all of the questions will help you meet the learning outcomes and better prepare you for the exam.

Definition of the unit step function that is used in some problems is given as

$$u(t-t_0)=\begin{cases}0 & t<t_0\\ 1 & t\geq t_0\end{cases}$$

Most of the following questions on first order circuits do not ask for the differential equation to be written, as it is relatively easy to write the solution directly. However it is good practice to derive and write the differential equation yourself first. This will help you to proceed to the second order questions more easily.

You may use the formula sheet provided on iLearn for all your assessment tasks.

I. Initial Conditions of Switched Circuits

P7.8-1, P7.8-2, P7.8-3,

P7.8-6 [0 V, 2.4 V], P7.8-7 [0 A, -1 A]

II. First Order Circuits with Constant Input

P8.3-1, P8.3-2, P8.3-3, P8.3-4, P8.3-15

P8.3-16 [(a) 16 V, 0.8 s (b) 19.2 V, 0.48 s]

P8.3-17

P8.3-21 [$(14.4+3.6\,e^{-5t})$ V]

P8.3-23 [$(1.75+5.25\,e^{-32t})$ A]

III. Sequential Switching

P8.4-1

$$v(t)=\begin{cases}10\ V & t\leq 0\\ (5+5\,e^{-5t})\ V & 0\leq t\leq 1.5\ s\\ 10-4.997\,e^{-2.5(t-1.5\ s)} & t\geq 1.5\ s\end{cases}$$

P8.4-2

P8.4-4 [0.0693 s, 25 µA]

P8.4-5

$$v(t)=\begin{cases}4\ \text{V} & t\leq 0\\ (12-8\,e^{-t})\ \text{V} & 0\leq t\leq 0.5\ \text{s}\\ \left(4+3.148\,e^{-3(t-0.5)}\right)\ \text{V} & t\geq 0.5\ \text{s}\end{cases}$$

IV. Unit Step Source

P8.6-1

$$v_0(t)=\begin{cases}8\ \text{V} & t\leq 0\\ (-7+15e^{-2500t})\ \text{V} & t\geq 0\end{cases}$$

P8.6-2

$$v_0(t)=\begin{cases}2\ \text{V} & t\leq 0\\ (4-2e^{-t})\ \text{V} & t\geq 0\end{cases}$$

P8.6-3

$$i_0(t)=\begin{cases}-1.4\ \text{A} & t\leq 0\\ (1.2-2.6e^{-1.85t})\ \text{A} & t\geq 0\end{cases}$$

V. First Order Circuits with Dependent Sources

P8.6-11

$$i(t)=\begin{cases}0.6\ \text{mA} & t\leq 0\\ (3-2.4e^{-333t})\ \text{mA} & t\geq 0\end{cases}$$

P8.6-12 (This is an unstable circuit!)

$$v(t)=\begin{cases}-4\ \text{V} & t\leq 0\\ (-2-2e^{5t})\ \text{V} & t\geq 0\end{cases}$$

P8.6-13

$$i(t)=\begin{cases}0\ \text{A} & t\leq 0\\ (1-e^{-0.6t})\ \text{A} & t\geq 0\end{cases}$$

VI. Natural Response of Second Order Circuits

P9.3-2

P9.3-3
[$s^2 + 102000s + 3 \times 10^8 = 0,\ s_1 = -3031,\ s_2 = -98969$]

VII. Natural Response of Unforced RLC Circuit

P9.4-1, P9.4-2 [$(-e^{-t}+3e^{-3t})$ V]

P9.4-3 [$(3e^{-t/6} + 8e^{-2t})$ A, $(-e^{-t/6} + 12e^{-2t})$ A]

VIII. Natural Response of Critically Damped Unforced RLC Circuit

P9.5-1, P9.5-2, P9.5-4

IX. Natural Response of Underdamped Unforced RLC Circuit

P9.6-2

X. Complete Response of RLC Circuit

P9.8-2, P9.8-4, P9.8-5, P9.8-9

References

[1] J. A. Svoboda, R. C. Dorf, "Introduction to Electric Circuits 9th edition," Wiley, 2014.