EXAM

1TE717 Digital Technologies and Electronics
Faculty of Electrical Engineering

2021–10–21, 14:00–19:00

Take-home Exam - Studium

Aids:

- Learning materials provided for this course
- A non-programmable scientific calculator (e.g. TI-83 and similar),
- MATLAB can only be used as a replacement of a scientific calculator

Observe: Do not treat more than one problem on each page.
Each step in your solutions must be motivated.
Lacking motivation will results in point deductions.
Write a clear answer to each question and clearly indicate which formulas are used.
Mark the total number of pages on the cover or first page
Mention the anonymous exam code on the top of the first page

The exam consists of 5 questions, for a total of 50 points. The points for each problem are also indicated.

Passing Grade: To pass the course, you need to successfully attain the learning goals of the course. This means that you would pass the exam if you obtain **at least 50%** of the combined total points of the final written exam and the assignment. Weight of the Exam = 75% and weight of the assignment = 25%.

Responsible: Arunava Naha, mobile phone: available in Studium.

Good Luck!

Total Points: 50

1

1.a Find the equivalent resistance between A and B for the circuit shown below.

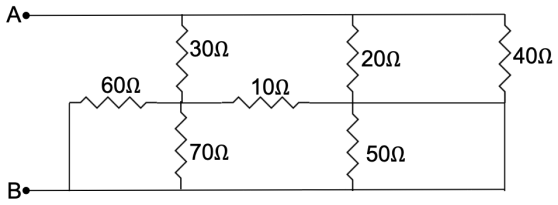

Figure 1: Circuit for Question 1.a.

(1.a: 5 pt)

1.b Find the magnitude and direction of the current flowing through the 5Ω resistor for the circuit shown below.

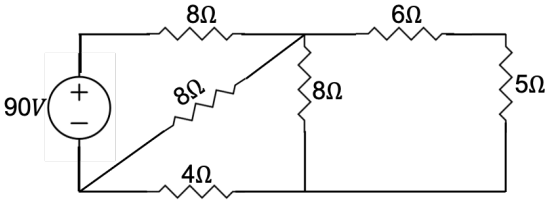

Figure 2: Circuit for Question 1.b.

(1.b: 5 pt)

(Sub-Total Question 1: 10 pt)

2

2.a Determine the voltage gain of the amplifier circuit shown below. Assume that the OpAmp is ideal.

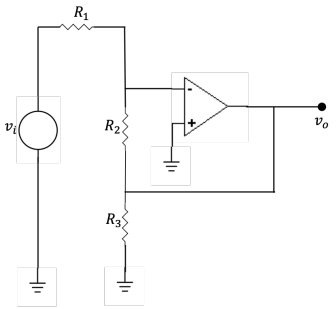

Figure 3: Circuit for Question 2.a.

(2.a: 4 pt)

2.b Determine the voltage gain of the amplifier circuit shown below. Assume that the OpAmp is ideal.

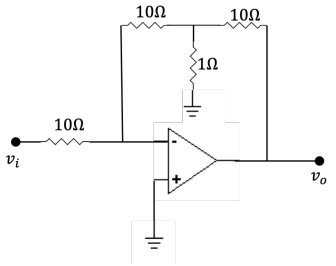

Figure 4: Circuit for Question 2.b.

(2.b: 6 pt)

(Sub-Total Question 2: 10 pt)

3

3.a Find the current through the collector for the following circuit. $V_{forward_{on}} = 0.7$V for both diode and transistor B-E junction. $V_{CE_{sat}} = 0.2$V, Current gain of the transistor $\beta = 30$, Zener voltage $V_z = 5$V.

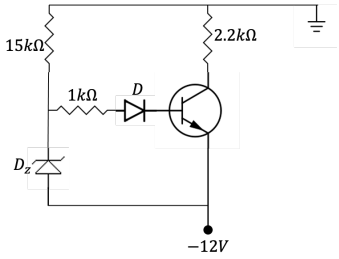

Figure 5: Circuit for Question 3.a.

(3.a: 6 pt)

3.b Assume the diodes are ideal for the following circuit. Find the value of v_o.

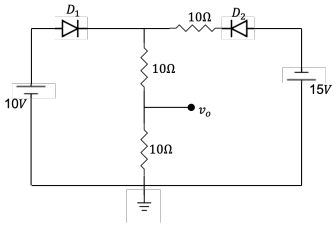

Figure 6: Circuit for Question 3.b.

(3.b: 2 pt)

3.c Find the value of the output voltage v_o of the circuit shown below?

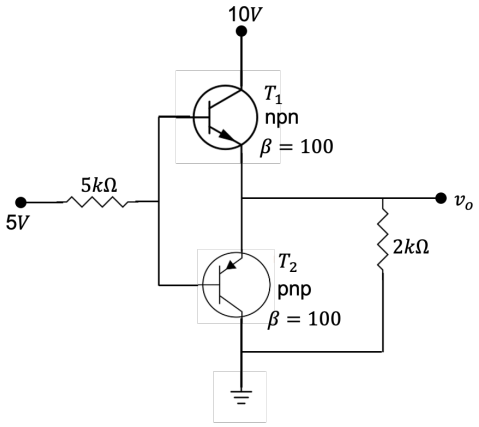

Figure 7: Circuit for Question 3.c.

(3.c: 2 pt)

(Sub-Total Question 3: 10 pt)

4

4.a A lawn sprinkling system is controlled automatically by a certain combination of the following variables.

i) Season, S ($S = 1$ if summer, $S = 0$ if any other season),
ii) Moisture content of soil, M ($M = 1$ if moisture content is high, $M = 0$ if low),
iii) Outside temperature, T ($T = 1$ if temperature is high, $T = 0$ if low), and
iv) Outside humidity, H ($H = 1$ if humidity is high, $H = 0$ if low).

The sprinkler should turn on under any of the following circumstances.

i) The moisture content is low in winter.
ii) The temperature is high, and the moisture content is low in summer.
iii) The temperature is high, and the humidity is high in summer.
iv) The temperature is low, and the moisture content is low in summer.
v) The temperature is high, and the humidity is low in all seasons.

Design the simplest possible logic circuit involving the variables S, M, T, and H for turning on the sprinkler system, using only 2 or 3 input NAND gates.

(4.a: 6 pt)

4.b Draw the state transition diagram for the sequential logic circuit shown below considering A as the only input. Show the intermediate steps for your work.

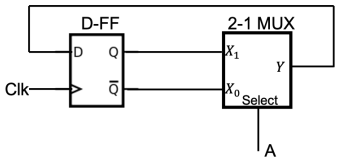

Figure 8: Circuit for Question 4.b.

(4.b: 2 pt)

4.c For the sequential digital circuit shown below, if the input clock frequency is f_{in}, what will be the frequency of the output signal? i.e., f_{out} =?.

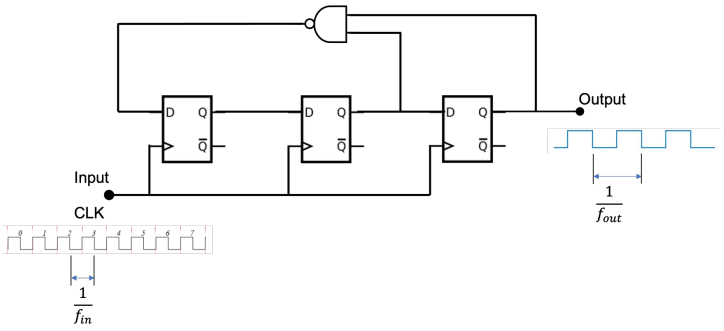

Figure 9: Circuit for Question 4.c.

(4.c: 2 pt)

(Sub-Total Question 4: 10 pt)

5

5.a The operational amplifier shown in the following figure is ideal. $v_i = 2\sin(2\pi \times 2000t)$. Determine the amplitude of the output voltage v_o in Volt.

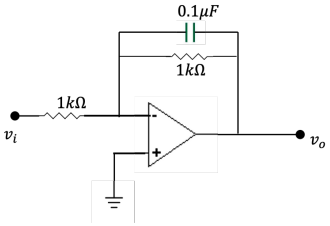

Figure 10: Circuit for Question 5.a.

(5.a: 5 pt)

5.b Determine the current $i(t)$ in terms of sinusoidal expression for the circuit shown below. $R = \frac{1}{3}\Omega$, $L = \frac{1}{4}$H, $C = 3$F, and $v(t) = \sin(2t)$.

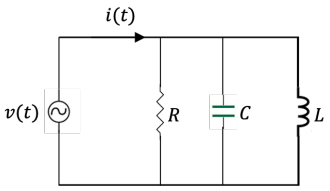

Figure 11: Circuit for Question 5.b.

(5.b: 5 pt)

(Sub-Total Question 5: 10 pt)