Solution Key

MEU جامعة الشرق الأوسط MIDDLE EAST UNIVERSITY
Amman - Jordan

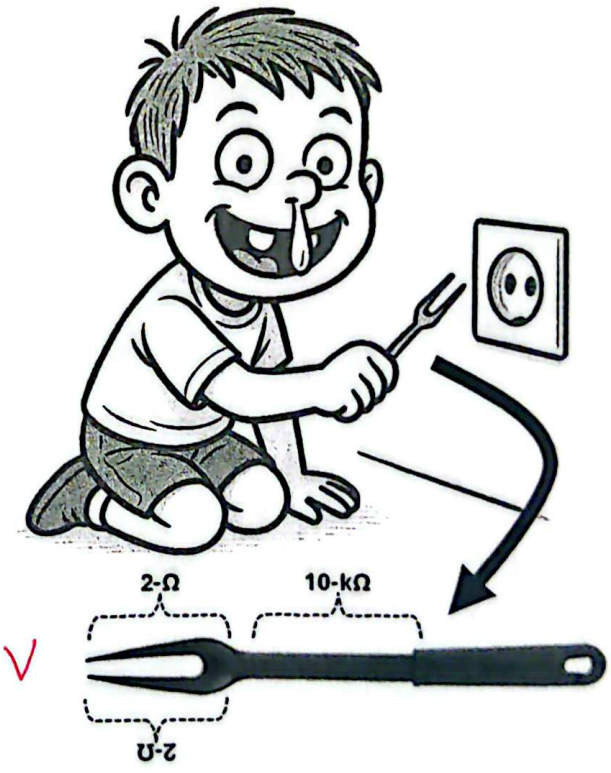
Exam Sheet

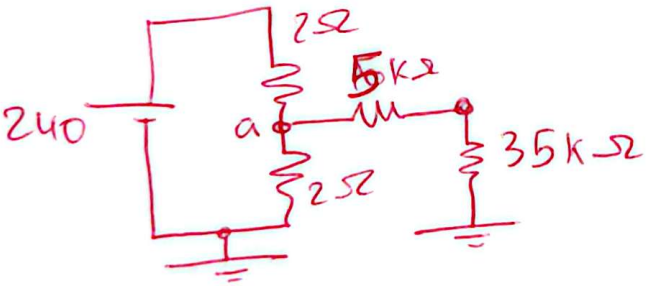
Faculty: Engineering and Design	Department: Renewable Energy Engineering
Academic Year: 2024/2025	Semester: 2nd Semester
Course Name and Number: Circuits I - 952501	
Instructor Name: A.J.	Coordinator Name:
Midterm Exam ■	Final Exam
Exam Date: 29/4/2025	Exam Time: 15:00-16:00
Exam Room Number: B203	
Student Name:	Student ID:

Problem No.	CLO	Full Points	Student's Point
Problem (0)+(1)	CLO (1)	15 Points	
Problem (2)+(3)	CLO (1)	12 Points	
Total		25 Points + 2 BONUS	

Problem 0 (CLO1) — **6 Points**

A naughty child is pushing a 2-throng fork (شوكة بحربتين) in a DC electrical socket with a voltage of 240V. One terminal of the socket is connected to earth and the other is +240V. The child is also sitting on earth. His resistance from hand to foot is 35-kΩ. The resistance of every throng (حربة) of the fork is 2-Ω. The fork's handle (مقبض الشوكة) is made of wood and a resistance of 5-kΩ. What current will run through the child? How much power will be consumed in the fork? DRAW the equivalent circuit first.





$$V_a = 240 * \frac{2//40K}{2+2//40K} = 119.997\ V$$

$$I_{child} = \frac{V_a}{40K} = \frac{119.997}{40K} = 2.999925\ mA \simeq 3mA$$

$$P_{fork} = P_{throng1} + P_{throng2} + P_{handle}$$

$$P_{throng\ 1} = \frac{V^2_{throng1}}{2} = \frac{(120.003)^2}{2} = 7200.36\ W$$

$$P_{throng2} = \frac{V^2_{throng2}}{2} = \frac{119.997^2}{2} = 7199.64$$

$$P_{handle} = I^2_{handle} \cdot R_{handle} = (2.999925m)^2 * 5K = 44.99775\ mW \simeq 45mW$$

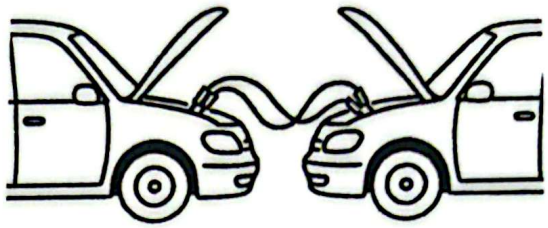
$$P_{fork} = 14,400.045\ W$$

I_{child} = 2.999925 mA	P_{fork} = 14,400.045 W

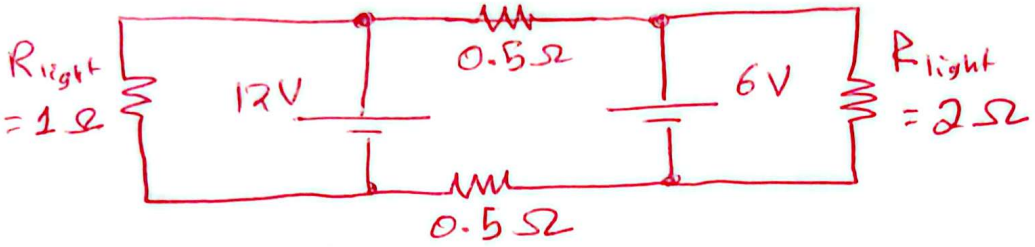
F134-01 (ABET) Rev. a
Ref.: Deans' Council Session (21/2022-2023) Decision No.: 01
Date: 05/02/2023

Problem 1 (CLO1)	9 Points

The car on the left is charging the battery of the car on the right. The car on the left has a battery with a voltage of 12-V. The one on the right has a battery that only has 6-V. The charging is happening using two cables as shown. Each cable has a resistance of 0.5-Ω. During charging the car on the left has its lights on. The lights are connected to the battery and have a resistance of 1-Ω. The car on the right also has its lights on and they have a resistance of 2-Ω.

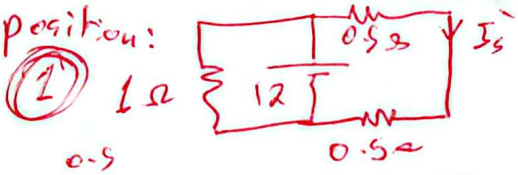


a) Draw the equivalent circuit of this problem.

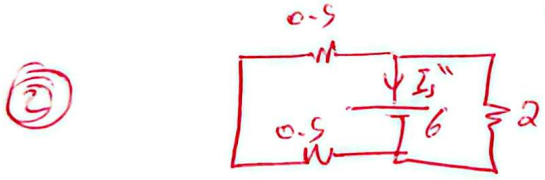


b) Find the power absorbed the 6-V battery of the car on the right.

Using superposition:



$I_s' = \frac{12}{0.5+0.5} = 12A$



$I_s'' = -\left(\frac{6}{2} + \frac{6}{0.5+0.5}\right) = -(3+6) = -9A$

$I_s = I_s' + I_s'' = 12 - 9 = 3A$

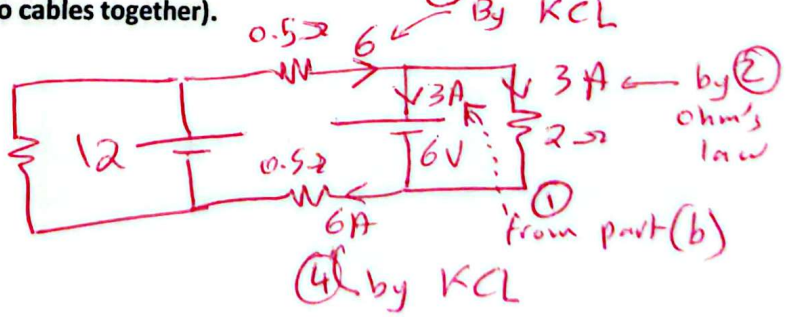
$P_{6V} = 6 * 3 = 18 Watt$

P_{6V} = 18 Watt

c) Find the power lost in the charging cables (the two cables together).

$P_{cables} = 6^2 * 0.5 + 6^2 * 0.5$

$= 36 Watt$

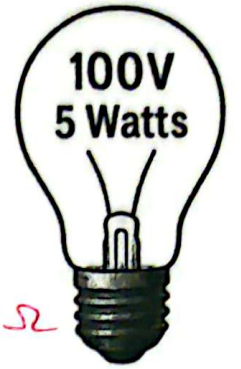


P_{cables} = 36 Watt

FI34-01 (ABET) Rev. a
Ref.: Deans' Council Session (21/2022-2023) Decision No.: 01
Date: 05/02/2023

Problem 2 (CLO1) | **6 Points**

You have 10 bulbs, each rated at 100V, 5 Watts. (i.e. When the bulb is connected to a 100 V DC source, it consumes 5 Watts). The bulb behaves like an ideal resistor. Answer the following:



a) If all 10 bulbs are connected in series, and are fed together from a single 100-V source, what is the total power they will consume in Watts?

$R_{bulb} = \frac{V^2}{P} = \frac{(100)^2}{5} = 2000\,\Omega$

For 10 bulbs in series: $R_{total} = 10 * 2000 = 20K\,\Omega$

$P_{total} = \frac{V^2}{R_{total}} = \frac{(100)^2}{20k} = 0.5\,W$

$P_{series} = 500\,mW$

b) If all 10 bulbs are connected in parallel, and are fed together from a 100-V source, what is the total power they will consume in Watts?

$P_{total} = 5 * 10 = 50\,W$

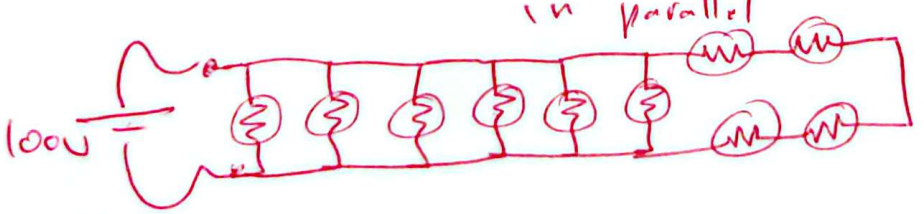
$P_{parallel} = 50W$

c) Draw a possible connection of the ten bulbs that would consume a total of 31.25 Watts when fed from a single 100V DC source.

$31.25 = 30 + 1.25$

30: 6 bulbs in parallel

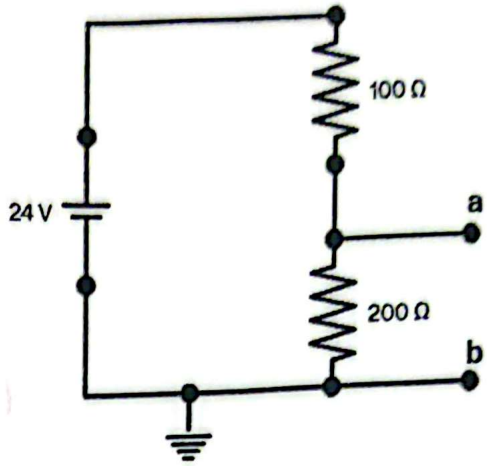
$1.25 = \frac{1}{4} * 5$ ⇒ 4 bulbs in series @ 100 V



F134-01 (ABET) Rev. a
Ref.: Deans' Council Session (21/2022-2023) Decision No.: 01
Date: 05/02/2023

Problem 3 (CLO1)	6 Points

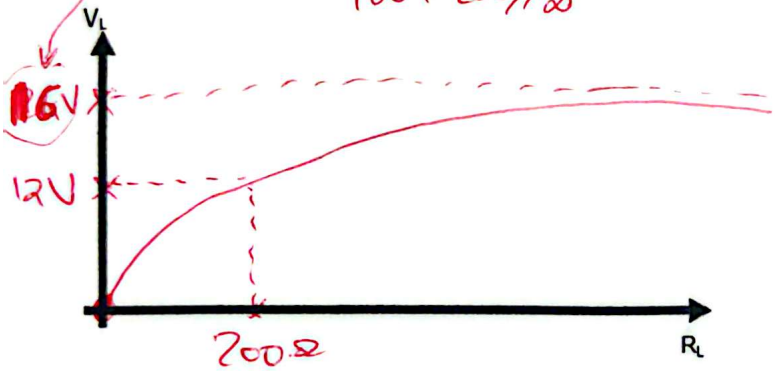
The circuit you see on the right is called a voltage divider. It is used to reduce the voltage of a high voltage source in order to feed a load that needs a lower voltage. The source here is 24-V. The load, R_L, will be connected between nodes (a) and (b) (in parallel with the 200-Ω resistor). Plot the following graphs as functions of the load resistance R_L:

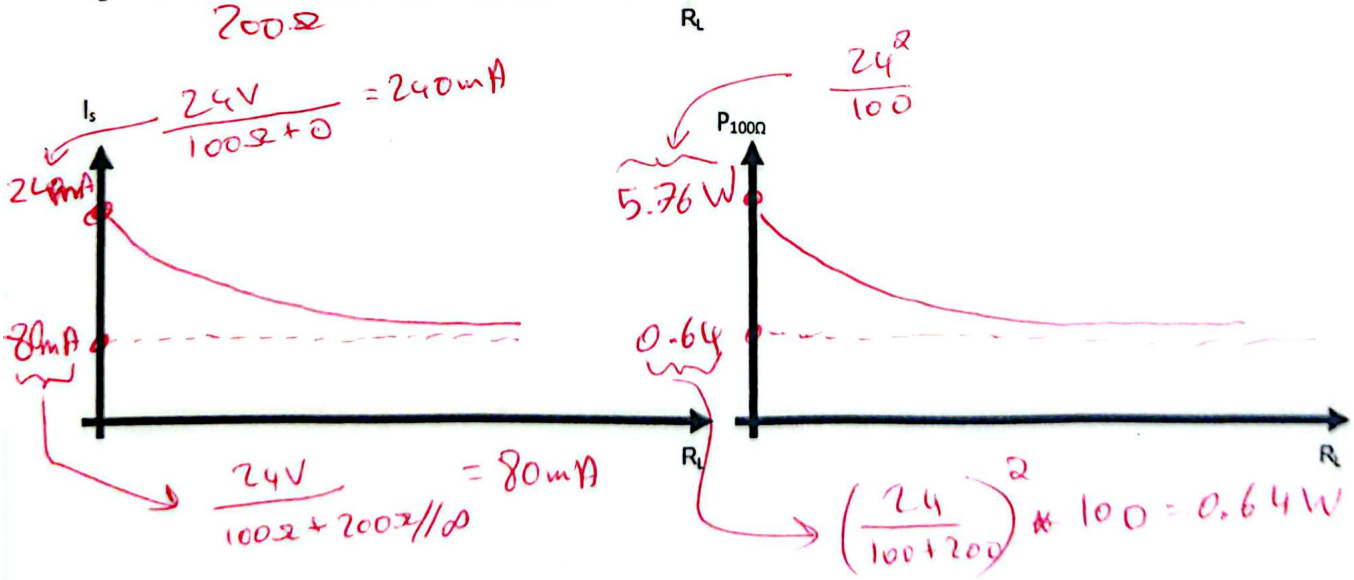


- **Load voltage V_L versus R_L**
- **Source current Is versus R_L**
- **Power dissipated in the 100-Ω resistor (P_{100}) versus R_L**

Clearly mark any important values on the x- and y-axes. Make sure the graphs clearly show the limiting behavior as R_L approaches infinity.

$24 * \frac{200//\infty}{100 + 200//\infty} = 16$





F134-01 (ABET) Rev. a
Ref.: Deans' Council Session (21/2022-2023) Decision No.: 01
Date: 05/02/2023