Circuits and System 1 - 2^{nd} Semester - Week 5

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Recap of design problems of chapter 3

In the last lecture (that we had on April 27, 2021), the performance in quiz was poor. So, let us practice some more design questions before we proceed to chapter 4.

Design Problem 1

The increasing number of Covid-19 patients has brought the healthcare system of the world to a collapse. Policy makers need to come up with a well-planned strategy for diagnosis and patient management in the light of the latest research on COVID-19. To devise a mechanism to test Covid-19 patients, Dr. Mohsin has built an electronic device that requires $\mathbf{250}\boldsymbol{V}$ dc voltage and $\mathbf{50}\boldsymbol{W}$ of dc power. If you have dc batteries of $\mathbf{200}\boldsymbol{V}$, can you design a circuit to operate the electronic device requiring $\mathbf{250}\boldsymbol{V}$ dc voltage and $\mathbf{50}\boldsymbol{W}$ dc power. You are free to use any value of resistor (as required) but use the combination of $\mathbf{200}\boldsymbol{V}$ batteries only (as required - may be two or three or four batteries as you think are required). Treat the electronic component as resistor (in your calculations). Use a rectangle symbol to denote the electronic device in your circuit schematic.

Design Problem 1 - Solution

Design Problem 2

A wireless sensor network (WSN) consists of one or more sensor nodes which are connected to a microcontroller. The mircrontroller communicates with outer world using a wireless network. Energy optimization in a wireless sensor network has been one of the most researched topic in the field of wireless communications. Numerous recent scientific publications have addressed this area. The main power usage in a sensor node is during its exchange of data with other sensor nodes in the network. Inside a sensor node, there is a sensing module connected to a microcontroller unit which has transmission and reception modules. The replacement of batteries is a big problem for remotely deployed sensor nodes. Dr. Mohsin has built a sensor node which can monitor temperature and humidity inside his home. The sensor node requires $\mathbf{5}\boldsymbol{W}$ and $\mathbf{5}\boldsymbol{V}$ to operate. If you are given a pool of $\mathbf{3}\boldsymbol{A}$ current sources, can you design a circuit to operate the sensor node and satisfy its exact power requirements. You are free to use any value of resistor (as required) and treat the sensor node as resistor (for calculation purposes) but use the combination of $\mathbf{3}\boldsymbol{A}$ current sources only (as required). Use a rectangle symbol to denote the sensor node in your circuit schematic.

Design Problem 3

Mountain climbing is an exciting activity. Infact, mountain climbing is an adventurous sports. In our country, people from cities having hot summers travel towards mountainous areas to enjoy the cold weather. Dr. Mohsin rents a Honda BRV from Careem enterprises and sets on a journey towards mountainous area. In mountainous areas, vehicles can travel up to a certain distance and the remaining journey is usually continued either by foot or through especial jeeps. Dr. Mohsin parks his Honda BRV in a safe place and then decides to follow a mountain track by foot. When he reaches the middle of the track, he realizes that he has forgotten his mobile charger in his home and now his mobile needs charging. You are also accompanying him in this journey and its your job to help him charge his mobile. At an electronics shop which is about 3 hours journey, you only find $\mathbf{1.5}\boldsymbol{V}$ batteries (or wall-clock cells) and a bundle of resistors. The mobile requires exactly $\mathbf{5}\boldsymbol{V}$ and $\mathbf{2}\boldsymbol{A}$ to get charge. Design a circuit using the $\mathbf{1.5}\boldsymbol{V}$ batteries to charge the mobile and show the schematic of circuit. Treat the mobile phone as resistor (in your calculations). Use a rectangle symbol to denote the mobile phone in your circuit schematic.

Design Problem 4

Continuing with design problem 3, if you have drawn the correct circuit schematic, so then attempt this problem also. If each battery of $\mathbf{1.5}\boldsymbol{V}$ has capacity of $\mathbf{200}\boldsymbol{mAhr}$, then compute the time for the $\mathbf{1.5}\boldsymbol{V}$ batteries to discharge.

Chapter 4 - Methods of Analysis of Resistive Circuits

Till now, we are familiar with 3 methods used in circuit analysis.

Ohm Law: $\boldsymbol{V = IR}$

KCL: Sum of current entering a node = sum of current leaving that node.

KVL: Algebraic sum of voltages in a loop is zero.

In chapter 4, we will study two more techniques for circuit analysis.