Pakistan Institute of Engineering and Applied Sciences

Department of Electrical Engineering

EE-111: CIRCUIT ANALYSIS

COMPLEX ENGINEERING PROBLEM (CEP)

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OBJECTIVES:

The home electrical circuit we made in this problem explains the practical applications of it and hence works as a framework for home wiring. It explains the significance of the parallel connection of the electrical appliances in the house. The circuit should also show resistors connected in parallel which is in accordance with the home circuits in practical perspective.

ABSTRACT:

The main goal of this complex engineering problem is to flourish the Circuit Analysis-I course. Usage of DC voltage source as main supply, resistors as devices and switches as keys, as we studied these electrical components in this course. This also flourishes all the formulas studies in our course. The laws studies in our course have also been used in practical perspective for resistance and voltage calculation.

RESOURCES:

We used the following software and applications for the circuit designing and numeric calculations.

- **MULTISIM** provides an interactive schematic environment to create and learn circuit designing. We made our complex engineering problem home circuit on this application using its functions giving DC Voltage Supply, resistances representing home electrical appliances, switches acting as keys etc.
- **MATLAB** provides numeric computing environment and programming in different languages. Power ratings of these electrical appliances are converted into the respective resistances and current across each load using Ohm’s Law.

ANALYTICAL APPROACH:

Our circuit includes a kitchen, a living hall, an attached dining hall, a master bedroom, a guest room and bedroom. The porch and backyard circuit were also designed. A clear study of the circuit also shows that all the rooms were connected in parallel with each other so that each one of them receives equal voltage and most important of all so that all the rooms remain separate with separate connections. On the other hand, in series circuit all the appliances will shut down to a fault in a single device. A voltage standard of 240V was used according to Pakistan's standard. A.C. source was not used to make our circuit simple which saved us from the problem of calculating phase of A.C. current which also might change in daily routine. So, an independent D.C. source was used instead. The appliances were symbolized by their resistances which were calculated by using power formula. The powers of home appliances were in accordance with power availability in national market. The capacitors and inductors are also a part of circuit but to make a simple home circuit as asked by complex engineering problem, they were not added so. Current across each device was also calculated and in the final perspective power absorbed and power delivered were compared.

OVERVIEW:

Our home circuit framework consists of following rooms:

- Garage
- Kitchen
- Living Room
- Dining Hall
- Master Bedroom
- Bedroom
- Guest Room
- Backyard

VALUES CALCULATED FOR THE APPLIANCES

For the given Power Rating in Watts (P) of each appliance and voltage source (V) of 240V, resistance value (R) in ohms is found. This R represents each load in the circuit diagram. And by Ohm's Law (V=I×R) current in amperes across each appliance is also found.

TUBELIGHT:

```
>> P = 40;
>> V = 240;
>> R = V^2 / P

R =

        1440

>> I = V / R

I =

    0.1667
```

LED LIGHT:

```
>> P = 15;
>> V = 240;
>> R = V^2 / P

R =

        3840

>> I = V / R

I =

    0.0625
```

FAN/CHANDELIER:

```
>> P = 60;
>> V = 240;
>> R = V^2 / P

R =

   960

>> I = V / R

I =

    0.2500
```

AIR CONDITIONER: (1.0 TON)

```
>> P = 1000;
>> V = 240;
>> R = V^2 / P

R =

   57.6000

>> I = V / R

I =

    4.1667
```

AIR CONDITIONER: (1.5 TON)

```
>> P = 1500;
>> V = 240;
>> R = V^2 / P

R =

   38.4000

>> I = V / R

I =

    6.2500
```

LAMP:

```
>> P = 60;
>> V = 240;
>> R = V^2 / P

R =

   960

>> I = V / R

I =

    0.2500
```

COMPUTER:

```
>> P = 200;
>> V = 240;
>> R = V^2 / P

R =

   288

>> I = V / R

I =

    0.8333
```

EXHAUST:

```
>> P = 90;
>> V = 240;
>> R = V^2 / P

R =

   640

>> I = V / R

I =

    0.3750
```

REFRIGERATOR:

```
>> P = 150;
>> V = 240;
>> R = V^2 / P

R =

   384

>> I = V / R

I =

    0.6250
```

MICROWAVE OVEN:

```
>> P = 1200;
>> V = 240;
>> R = V^2 / P

R =

    48

>> I = V / R

I =

     5
```

TELEVISION: (20'')

```
>> P = 100;
>> V = 240;
>> R = V^2 / P

R =

   576

>> I = V / R

I =

    0.4167
```

TELEVISION: (28'')

```
>> P = 150;
>> V = 240;
>> R = V^2 / P

R =

   384

>> I = V / R

I =

    0.6250
```

WASHING MACHINE:

```
>> P = 325;
>> V = 240;
>> R = V^2 / P

R =

  177.2308

>> I = V / R

I =

    1.3542
```

ELECTRIC IRON:

```
>> P = 750;
>> V = 240;
>> R = V^2 / P

R =

   76.8000

>> I = V / R

I =

    3.1250
```

WATER PUMP:

```
>> P = 750;
>> V = 240;
>> R = V^2 / P

R =

   76.8000

>> I = V / R

I =

    3.1250
```

ELECTRIC GEYSOR:

```
>> P = 1500;
>> V = 240;
>> R = V^2 / P

R =

   38.4000

>> I = V / R

I =

    6.2500
```

FORMULAE USED FOR CALCULATIONS:

- $R = V^2 / P$
- $I = V / R$

VALUES CALCULATED FOR THE APPLIANCES WITH THE GIVEN POWER RATING (USING MATLAB)

APPLIANCES	POWER RATING(W)	RESISTANCE (Ω)	CURRENT (A)
TUBELIGHT	40	1440.0	0.1667
LED LIGHT	15.00	3840.0	0.0625
CEILING FAN	60.00	960.00	0.2500
AC (1.0 TON)	1000	57.600	4.1667
AC (1.5 TON)	1500	38.400	6.2500
LAMP	60.00	960.00	0.2500
COMPUTER	200.0	2880.0	0.8333
EXHAUST FAN	90.00	640.00	0.3750
REFRIGERATOR	150.0	384.00	0.6250
MICROWAVE OVEN	1200	48.000	5.0000
T.V. (20’’)	100.0	576.00	0.4167
T.V. (28’’)	150.0	384.00	0.6250
WASHING MACHINE	325.0	177.23	1.3542
ELECTRIC IRON	750.0	76.800	3.1250
WATER PUMP	750.0	76.800	3.1250
ELECTRIC GEYSOR	1500	38.400	6.2500
CHANDELIER	60.00	960.00	0.2500

TOTAL POWER (WHEN EVERY APPLIANCE IS RUNNING)

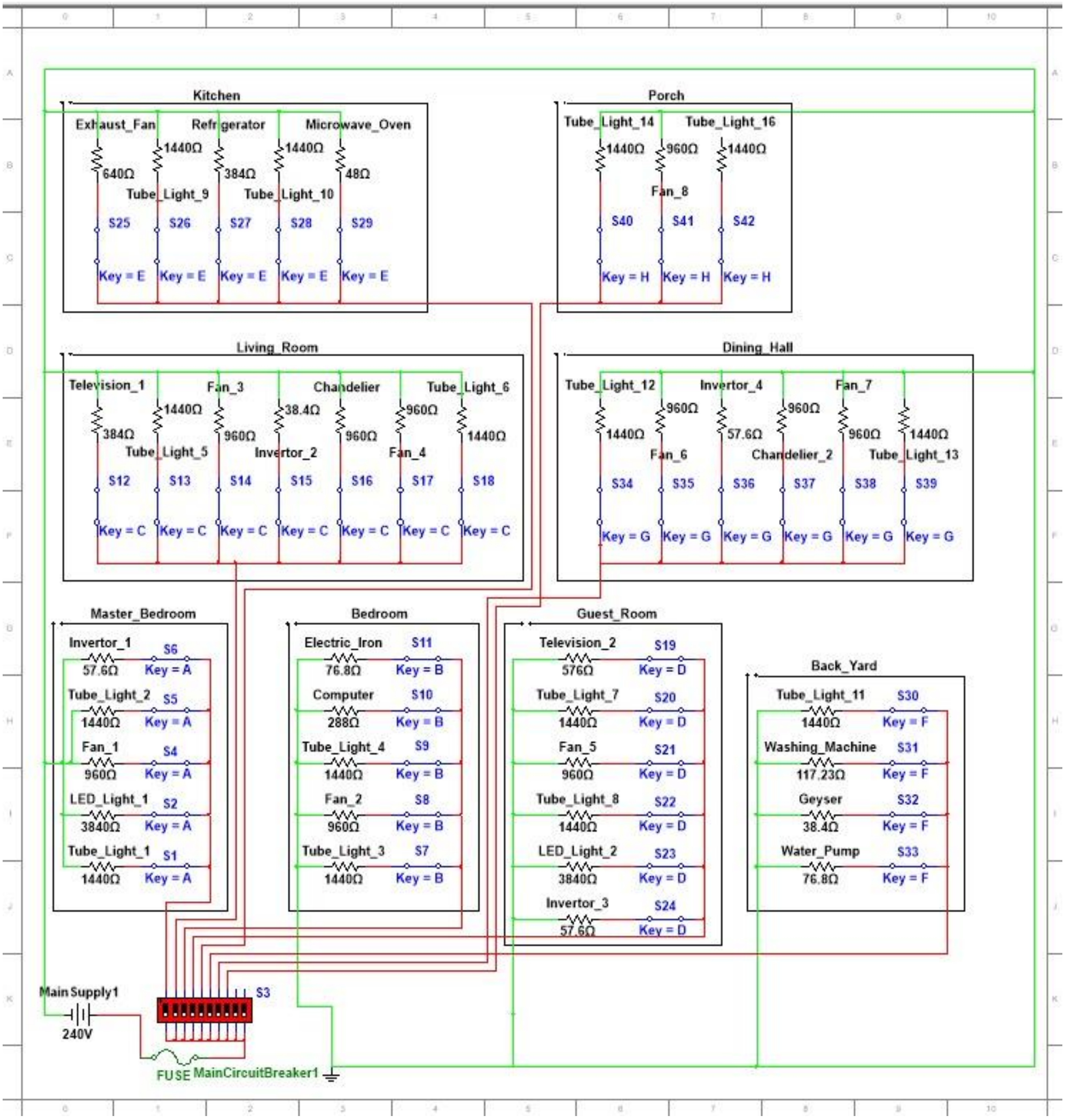
P_{MAX} (ABSORBED):

```
>> Ptotal = 16*40+2*15+8*60+3*1000+1500

Ptotal =

       11045
```

P_{MAX} (DELIVERED):

```
>> Vmax

Vmax =

   240

>> Imax

Imax =

   46.0212

>> Pmax = Imax * Vmax

Pmax =

   1.1045e+04
```

CIRCUIT DIAGRAM



ERRORS AND UNCERTAINTIES

In this complex engineering problem, we used ideal devices and resistors that are practically impossible. Following are some errors regarding our complex engineering problem:

1. First of all, we used an ideal D.C. Current Source that is practically impossible. In practical perspective, A.C. Current source is used because the voltage does not remain same. It varies continuously. Moreover, the household appliances used in our home circuit are also designed so to bear continuous change in magnitude of voltage. On the

other hand, our home circuit consists of an ideal D.C. Voltage source whose value remains same throughout.
2. Moreover, we have not considered the internal resistance of wire that causes change in power ratings of resistances. On the other hand, we have just used power ratings calculated by using simple Ohm's Law.
3. We have considered a magnitude of 240V as standard whose value is not changing throughout. On the other hand, according to practical house wiring, the voltage of A.C. Current source changes continuously.
4. As we are not able to use A.C. Source, so frequency of A.C. Source is also not standard because D.C. Current has no frequency. In Pakistan, the frequency of A.C. Current is 50Hz.
5. Because of use of D.C. source, we are not able to use transformers and plugs that are used in heavy power absorbing devices like air conditioners and refrigerators. On the other hand, we have just calculated their powers by simple Ohm's Law that is not according to a practical home circuit.
6. If resistances of appliances are considered, we have not calculated their tolerances that is not according to a practical home circuit.

   Our home circuit gives a very fine example of a standard home circuit but because of all these uncertainties our circuit is not according to a standard home circuit that can be observed in reality.

CONCLUSION

This complex engineering problem is not according to a standard home circuit but it has many more benefits.

1. It enhances our practical skills and our use of different technical soft wares like MATLAB and MULTISIM. These soft wares are not only used to construct a home circuit but also calculate current measurements and power ratings.
2. From this complex engineering problem, we have also learned how theoretical work can be converted to useful practical workout.
3. After designing a home circuit, we also learned how to form simple circuits by connecting resistors and appliances in series and how a voltage source is connected with respect to the resistors. Moreover, we also found out that the resistors are then connected to ground instead of connecting them to any negative terminal of battery.
4. We also observed the basic electrical laws like Ohm's Law and how are they used so far home circuit designing is considered.

To conclude this complex engineering problem was a relationship between theoretical and practical work that not only enhanced our knowledge of governing laws that can be used in circuit designing but also refreshed our practical circuit designing skills.

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