

Electrical load Calculations

IT and Software block, Mirpur University of Science and Technology,

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Contents

1.	Introduction.....	3
2.	Data collection and required parameters.....	3
3.	Methodology	4
4.	Calculation of Daily Load	5
5.	Monthly Load	7
6.	Monthly Tariff for calculated load.....	7
7.	Software Engineering Department.....	9
7.1.	Daily and Monthly Load Calculations.....	9
7.2.	Load curve	13
7.3.	Monthly tariff	15

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1. Introduction

This Document aims to provide a thorough electric load analysis for the Information Technology (IT) and software block of the university. It helps in understanding the energy consumption patterns, identifying potential areas for energy savings, and planning for future energy needs. The Software and IT block, houses a wide range of electrical equipment including lighting fixtures, fans, projectors, computing devices, air conditioners, and other office equipment. Each of these components contributes to the overall electric load of the building, and their usage patterns vary throughout the day. This report provides a detailed breakdown of the power consumption of each type of equipment, taking into account their wattage, usage hours, and relevant factors such as diversity and power factors.

By systematically calculating the daily and monthly electric load, this analysis aims to provide a clear understanding of the building's energy requirements. The results of this study will be instrumental for the university's facility management team to optimize energy usage, improve sustainability practices, and ensure the electrical infrastructure meets current and future demands efficiently.

2. Data collection and required parameters

In order to calculate the electric load of the building, we will need detailed information about the various electrical components and their usage within the building. Here are the key requirements and steps to calculate the load:

- Electrical Appliances and Equipment
- HVAC (Heating, Ventilation, and Air Conditioning)
- Lighting
- Usage Patterns and equipment specifications

Equipment	Quantity	Wattage per Unit	Usage Hours (per day)	Usage Factor	Diversity Factor
CFL Lights	32	20W	8 hours	1	0.9
LED Lights	119	15W	8 hours	1	0.9
Tube Lights	70	35W	8 hours	1	0.9
Ceiling Fans	67	75W	8 hours	1	0.9
Wall Bracket Fans	7	55W	8 hours	1	0.9
Projectors	4	50W	4 hours	0.5	0.8
CCTV Cameras	12	10W	8 hours	1	1
Water Coolers	2	500W	8 hours	1	0.8
Microwave Oven	1	1200W	1 hour	0.125	0.5
Office PCs	11	250W	8 hours	0.8	0.9
Office Photocopiers	2	800W	1 hour	0.125	0.5
Office Printers	3	50W	1 hour	0.125	0.5
Lab PCs	61	250W	6 hours	0.75	0.8
Air Conditioners (1 ton)	4	1500W	8 hours	1	0.8
42-inch LEDs	3	100W	4 hours	0.5	0.8

3. Methodology

3.1. Equipment listing and categorization: Categorize all electrical loads into lighting, HVAC, appliances, and miscellaneous

3.2. Calculate Individual Loads: For each category, calculate the total power consumption.

$$Total\ Load = Number\ of\ Units \times Power\ Rating \times Operating\ Hours$$

3.3. Sum the Loads: Sum up the loads for each category to get the total connected load.

3.4. Apply Diversity Factor: Apply a diversity factor to account for the fact that not all equipment operates at full load simultaneously. The diversity factor is typically less than 1 and varies depending on the type of building and usage patterns.

3.5. Calculate monthly load: To find the monthly load sum up the daily individual loads of each equipment and then multiply with the number of operating days in a month.

4. Calculation of Daily Load:

First, calculate the daily load for each type of equipment, using;

$$\text{Daily Load (Wh)} = \text{Quantity} \times \text{Wattage} \times \text{Usage Hours} \times \text{Usage Factor} \times \text{Diversity Factor}$$

- **CFL Lights:**

$$\text{Daily load} = 32 \times 20 \times 8 \times 1 \times 0.9 = 4608 \text{ Wh}$$

- **LED Lights:**

$$\text{Daily load} = 119 \times 15 \times 8 \times 1 \times 0.9 = 12852 \text{ Wh}$$

- **Tube Lights:**

$$\text{Daily load} = 70 \times 35 \times 8 \times 1 \times 0.9 = 17640 \text{ Wh}$$

- **Ceiling Fans:**

$$\text{Daily load} = 67 \times 75 \times 8 \times 1 \times 0.9 = 36180 \text{ Wh}$$

- **Wall Bracket Fans:**

$$\text{Daily load} = 7 \times 55 \times 8 \times 1 \times 0.9 = 2772 \text{ Wh}$$

- **Projectors:**

$$\text{Daily load} = 4 \times 50 \times 4 \times 0.5 \times 0.8 = 320 \text{ Wh}$$

- **CCTV Cameras:**

$$\text{Daily load} = 12 \times 10 \times 8 \times 1 \times 1 = 960 \text{ Wh}$$

- **Water Coolers:**

$$\text{Daily load} = 2 \times 500 \times 8 \times 1 \times 0.8 = 6400 \text{ Wh}$$

- **Microwave Oven:**

$$\text{Daily load} = 1 \times 1200 \times 1 \times 0.125 \times 0.5 = 75 \text{ Wh}$$

- **Office PCs:**

$$\text{Daily load} = 11 \times 250 \times 8 \times 0.8 \times 0.9 = 15840 \text{ Wh}$$

- **Office Photocopiers:**

$$\text{Daily load} = 2 \times 800 \times 1 \times 0.125 \times 0.5 = 100 \text{ Wh}$$

- **Office Printers:**

$$\text{Daily load} = 3 \times 50 \times 1 \times 0.125 \times 0.5 = 9.375 \text{ Wh}$$

- **Lab PCs:**

$$\text{Daily load} = 61 \times 250 \times 6 \times 0.75 \times 0.8 = 55050 \text{ Wh}$$

- **Air Conditioners (1 ton):**

$$\text{Daily load} = 4 \times 1500 \times 8 \times 1 \times 0.8 = 38400 \text{ Wh}$$

- **42-inch LEDs:**

$$\text{Daily load} = 3 \times 100 \times 4 \times 0.5 \times 0.8 = 480 \text{ Wh}$$

Total Daily Load:

$$4608 + 12852 + 17640 + 36180 + 2772 + 320 + 960 + 6400 + 75 + 15840 + 100 + 9.375 \\ + 55050 + 38400 + 480 = 191686.375 \text{ Wh/day}$$

Convert to kWh:

$$191686.375 \text{ Wh/day} \div 1000 = \mathbf{191.686 \text{ kWh/day}}$$

5. Monthly Load

University operates for approximately 22 days in a month (excluding weekends).

$$\text{Monthly Load} = 191.686 \text{ kWh/day} \times 22 \text{ days} = \mathbf{4217.092 \text{ kWh/month}}$$

6. Monthly Tariff for calculated load

Based on the information gathered from the AJK Electricity Department's official website, here are the relevant tariffs applicable to the Software and IT block at the university in Mirpur, Azad Kashmir:

6.1. Tariff Categories:

General Services (Applicable to Educational Institutions):

- **Fixed Charges:** Rs. 29.81 per kW per month
- **Variable Charges:** Rs. 29.81 per kWh

6.2. Calculation of Monthly Cost:

Given the previously calculated monthly load of 4217.092 kWh, the cost calculation can be divided into two parts: fixed charges and variable charges.

Fixed Charges:

The connected load is based on the total wattage of all equipment in use.

$$\text{Total wattage} = \sum(\text{Quantity} \times \text{Wattage per Unit})$$

$$(\text{Total wattage of all equipment}): 191686.375 \text{ W (191.686 kW)}$$

$$\text{Fixed charges for connected load: } 191.686 \text{ kW} \times 29.81 \text{ Rs/kW} = 5711.69 \text{ Rs/month}$$

Variable Charges:

The variable charges are based on the energy consumption (kWh).

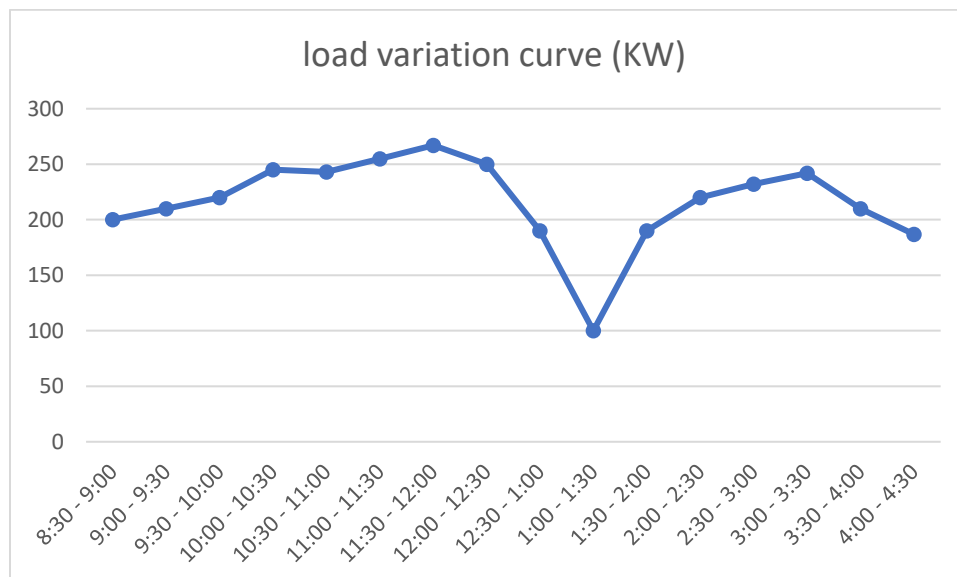
$$\text{Monthly energy consumption: } 4217.092 \text{ kWh}$$

Variable charges: 4217.092 kWh×29.81 Rs/kWh=125640.98 Rs/month

$$\text{Total Monthly Cost} = \text{Fixed Charges} + \text{Variable Charges}$$

$$\text{Total Monthly Cost} = 5711.69 \text{ Rs} + 125640.98 \text{ Rs} = 131352.67 \text{ Rs/month}$$

Time Interval	Total load (KW)
8:30 - 9:00	200
9:00 - 9:30	210
9:30 - 10:00	220
10:00 - 10:30	245
10:30 - 11:00	243
11:00 - 11:30	255
11:30 - 12:00	267
12:00 - 12:30	250
12:30 - 1:00	190
1:00 - 1:30	100
1:30 - 2:00	190
2:00 - 2:30	220
2:30 - 3:00	232
3:00 - 3:30	242
3:30 - 4:00	210
4:00 - 4:30	187



7. Software Engineering Department

Equipment	Quantity	Wattage (W)	Total Wattage (W)
LED Lights	136	20	2,720
Tube Lights	26	35	910
Ceiling Fans	38	75	2,850
Wall Bracket Fans	6	55	330
Projectors	4	50	200
CCTV Cameras	6	10	60
Water Coolers	3	400*	1,200
Office PCs	11	300*	3,300
Office Photocopier	1	800	800
Office Printers	3	250*	750
Lab PCs (HP)	70	300*	21,000
AC (1 ton each)	7	1,200*	8,400
LED TVs (42 inch)	2	150*	300
Neon Gas Lights	4	100*	400
Electronic Whiteboard	1	200*	200

7.1. Daily and Monthly Load Calculations

$$\text{Daily Load (Wh)} = \text{Total Wattage (W)} \times \text{Hours/Day}$$

$$\text{Monthly Load (Wh)} = \text{Daily Load (Wh)} \times \text{Operational Days}$$

Usage factors

Usage factors for equipment that are not in continuous use:

- Office PCs, Printers, Lab PCs, Photocopier, and Projectors assumed to operate 5 hours/day.
- ACs assumed to operate 6 hours/day

Load Calculation

- LED Lights

$$\text{Daily Load: } 2720 \times 8 = 21760 \text{ Wh}$$

$$\text{Monthly Load: } 21,760 \times 22 = 478,720 \text{ Wh}$$

- Tube Lights:

$$\text{Daily Load: } 910 \times 8 = 7280 \text{ Wh}$$

$$\text{Monthly Load: } 7,280 \times 22 = 160160 \text{ Wh}$$

- Ceiling Fans:

$$\text{Daily Load: } 2,850 \times 8 = 22,800 \text{ Wh}$$

$$\text{Monthly Load: } 22,800 \times 22 = 501,600 \text{ Wh}$$

- Wall Bracket Fans:

$$\text{Daily Load: } 330 \times 8 = 2640 \text{ Wh}$$

$$\text{Monthly Load: } 2,640 \times 22 = 58,080 \text{ Wh}$$

- Projectors:

$$\text{Daily Load: } 200 \times 5 = 1,000 \text{ Wh}$$

$$\text{Monthly Load: } 1,000 \times 22 = 22,000 \text{ Wh}$$

- CCTV Cameras

$$\text{Daily Load: } 60 \times 8 = 480 \text{ Wh}$$

$$\text{Monthly Load: } 480 \times 22 = 10,560 \text{ Wh}$$

- Water Coolers:

Daily Load: $1,200 \times 8 = 9,600 \text{ Wh}$

Monthly Load: $9,600 \times 22 = 211,200 \text{ Wh}$

- Office PCs:

Daily Load: $3,300 \times 5 = 16,500 \text{ Wh}$

Monthly Load: $16,500 \times 22 = 363,000 \text{ Wh}$

- Office Photocopier:

Daily Load: $800 \times 5 = 4,000 \text{ Wh}$

Monthly Load: $4,000 \times 22 = 88,000 \text{ Wh}$

- Office Printers:

Daily Load: $750 \times 5 = 3,750 \text{ Wh}$

Monthly Load: $3,750 \times 22 = 82,500 \text{ Wh}$

- Lab PCs (HP):

Daily Load: $21,000 \times 5 = 105,000 \text{ Wh}$

Monthly Load: $105,000 \times 22 = 2,310,000 \text{ Wh}$

- ACs (1 ton each):

Daily Load: $8,400 \times 6 = 50,400 \text{ Wh}$

Monthly Load: $50,400 \times 22 = 1,108,800 \text{ Wh}$

- LED TVs (42 inch):

Daily Load: $300 \times 8 = 2,400 \text{ Wh}$

Monthly Load: $2,400 \times 22 = 52,800 \text{ Wh}$

- Neon Gas Lights:

Daily Load: $400 \times 8 = 3,200 \text{ Wh}$

Monthly Load: $3,200 \times 22 = 70,400 \text{ Wh}$

- Electronic Whiteboard:

$$\text{Daily Load: } 200 \times 8 = 1,600 \text{ Wh}$$

$$\text{Monthly Load: } 1,600 \times 22 = 35,200 \text{ Wh}$$

Total Monthly Load Calculation

Total Monthly Load (Wh)

$$= 478,720 + 160,160 + 501,600 + 58,080 + 22,000 + 10,560 + 211,200 + 363,000 \\ + 88,000 + 82,500 + 2,310,000 + 1,108,800 + 52,800 + 70,400 + 35,200$$

$$\text{Total Monthly Load (Wh)} = \frac{5553020}{1000} \text{ Wh}$$

$$\text{Total Monthly Load (kWh)} = 5,553.02 \text{ kWh}$$

Applying Diversity Factor: Assume a diversity factor of 0.8 (not all equipment is used at the same time).

$$\text{Adjusted Monthly Load (kWh)} = 5553.02 \times 0.8 = 4442.416 \text{ kWh}$$

Power Factor: Assume a power factor of 0.9 for the entire block.

$$\text{Effective Load (kWh)} = 4,442.416 \times 0.9 = 3,998.1744 \text{ kWh}$$

The effective monthly load for the university block, considering diversity and power factor, is approximately **3,998.17 kWh**.

7.2. Load curve

Interval	LED Lights	Tube Lights	Ceiling Fans	Wall Bracket Fans	Projectors	Office PCs	Lab PCs	ACs	Other Equipment	Total Load (W)
8:30 - 9:00	2,720	910	2,850	330	50	1,650	7,500	2,800	2,710	21,520
9:00 - 9:30	2,720	910	2,850	330	50	1,650	7,500	2,800	2,710	21,520
9:30 - 10:00	2,720	910	2,850	330	50	1,650	7,500	2,800	2,710	21,520
10:00 - 10:30	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
10:30 - 11:00	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
11:00 - 11:30	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220
11:30 - 12:00	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220
12:00 - 12:30	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220
12:30 - 1:00	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220

1:00 - 1:30	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220
1:30 - 2:00	2,720	910	2,850	330	200	3,300	15,000	4,200	2,710	32,220
2:00 - 2:30	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
2:30 - 3:00	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
3:00 - 3:30	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
3:30 - 4:00	2,720	910	2,850	330	200	3,300	15,000	3,600	2,710	31,620
4:00 - 4:30	2,720	910	2,850	330	200	3,300	15,000	2,800	2,710	30,820

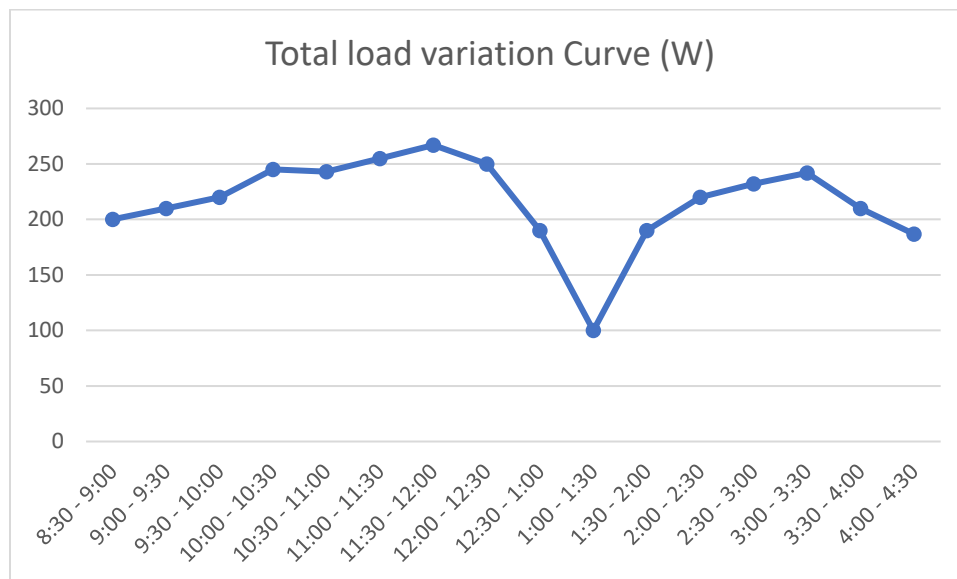


Figure 1 Load variation with time

7.3. Monthly tariff

Based on the electricity tariff information provided by the AJK Electricity Department for Mirpur, Azad Kashmir, the applicable tariff for educational institutions falls under the "General Services" category.

General Services Tariff

- Fixed Charges: Rs. 29.81 per kW per month
- Variable Charges: Rs. 31.93 per kWh

We previously calculated the total monthly load for the university block to be approximately 3,998.17 kWh.

Fixed Charges Calculation:

$$\text{Fixed Charges} = 100 \text{ kW} \times \text{Rs. } 29.81 = \text{Rs. } 2981 \text{ per month}$$

Variable Charges Calculation:

$$\text{Variable Charges} = 3998.17 \text{ kWh} \times \text{Rs. } 31.93 = \text{Rs. } 127692.49 \text{ per month}$$

Total Monthly Electricity Cost:

$$\text{Total Cost} = \text{Fixed Charges} + \text{Variable Charges}$$

$$\text{Total Cost} = \text{Rs. } 2,981 + \text{Rs. } 127,692.49 = \text{Rs. } 130,673.49 \text{ per month}$$

