DESIGN TASK
ELECTRICAL INSTALLATION

EC8010 – ELECRTICAL & ELECTRONIC ENGINEERING DESIGN PROFICIENCY

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1.INTRODUCTION

This report presents the design and implementation of an electrical installation system for the Engineering Faculty canteen at the University of Jaffna. The objective of this task is to develop a safe, efficient, and reliable electrical layout that meets the power requirements of all equipment installed in the canteen while complying with engineering standards and practical constraints.

The canteen layout includes equipment such as chillers, freezers, rice cookers, tea makers, RO plant, exhaust fans, ceiling fans, stand fans, and lighting fixtures. Each device's rated power is adjusted according to the group members' student numbers, in line with the task requirements.

No.	Equipment	Total No. of Equipment	Rated power(W)	P.F
1	Chillers	3	1035	0.95
2	Freezer	1	1036	0.75
3	Rice cooker	3	3086	0.99
4	Tea Maker	1	1171	0.99
5	RO plant	1	4207	0.80
6	Exhaust fan	2	20	0.70
7	Ceiling fan	8	35	0.70
8	Stand fan	2	35	0.70
9	lights	16	15	0.95

The power supply is provided from a panel board located 50 meters away, which necessitates careful planning to minimize voltage drop and ensure proper cable sizing and protection.

To achieve this, the report covers key stages of the design process, including:

- Identification of electrical loads and demand calculation
- Proposal of socket outlet arrangements, distribution board (DB) locations, and cable paths
- Voltage drop analysis and suitable cable size selection
- Selection of appropriate protective devices and rating of the main incomer
- Preparation of a 2D CAD layout and single line diagram (SLD)

This design ensures user safety, operational efficiency, and compliance with electrical engineering standards. The report combines theoretical calculations with practical implementations, making it a comprehensive solution for the electrical installation of the canteen.

2.ARRANGEMENT OF SOCKET OUTLET, DB LOCATIONS, AND CABLE PATH FOR THE MACHINES

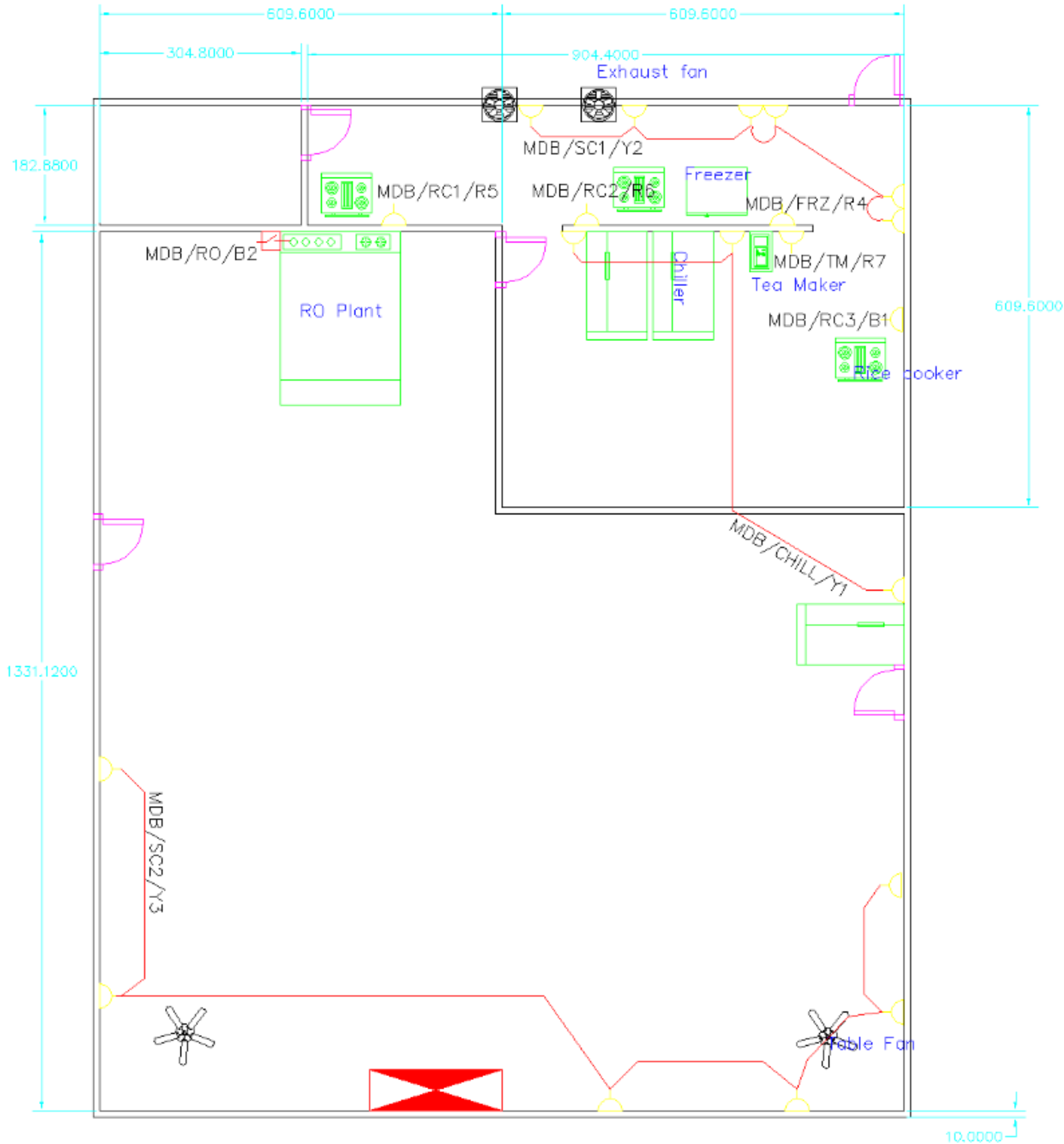

Figure 1: Power Circuit

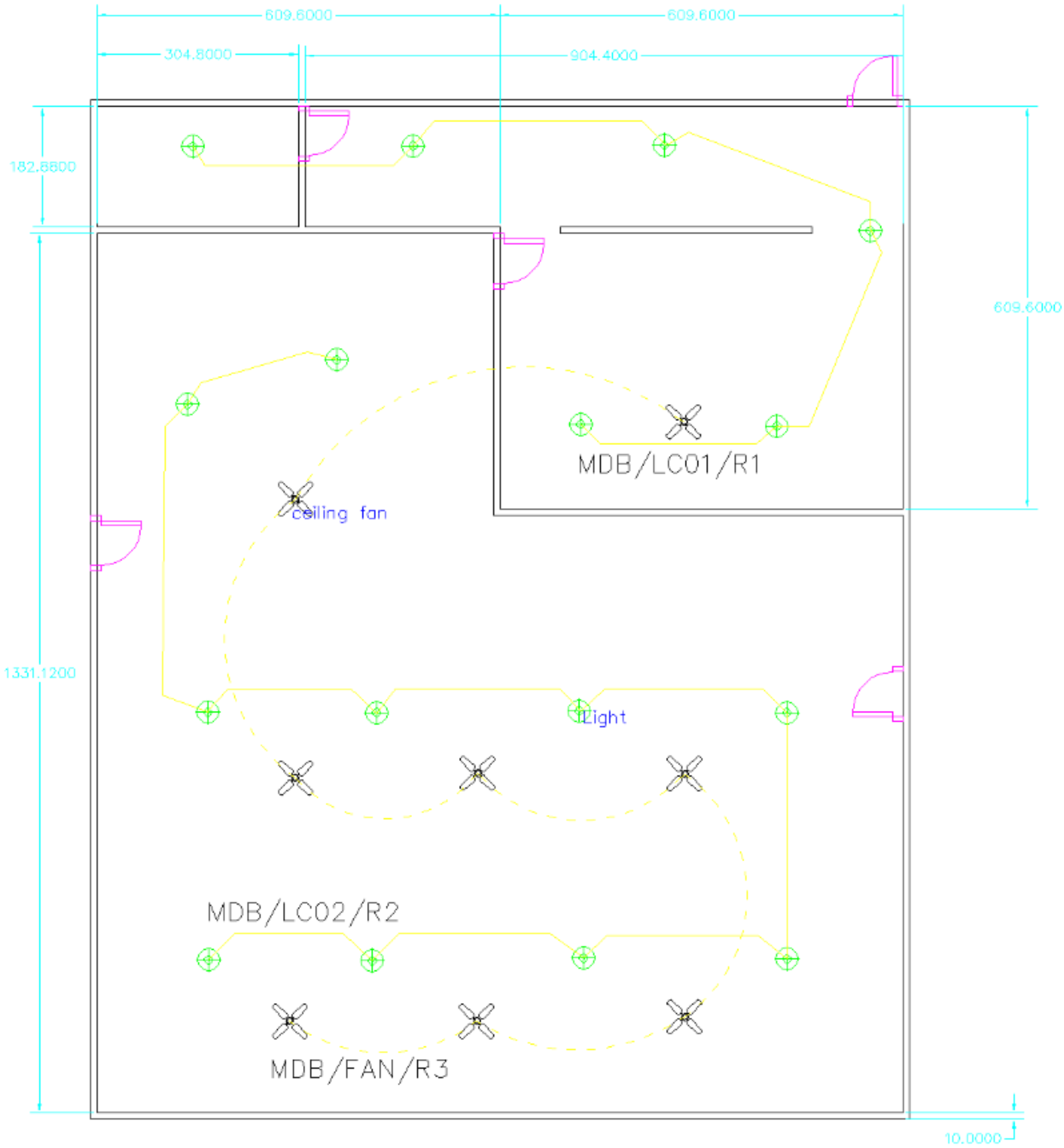

Figure 2: Lighting circuit

3.DEMAND CALCULATIONS

Formulas:

1. Motor / machine input electrical power (real power)

$$P_{\text{in}} = \frac{P_{\text{out}}}{\eta} \quad (\text{kW})$$

2. Three-phase line current

$$I_{3\phi} = \frac{1000 \cdot P_{\text{in}}(\text{kW})}{\sqrt{3} \cdot V_L \cdot pf} \quad (\text{A})$$

3. Single-phase current

$$I_{1\phi} = \frac{1000 \cdot P_{\text{in}}(\text{kW})}{V \cdot pf} \quad (\text{A})$$

4. Three-phase voltage drop (approximate, R only)

$$\Delta V \approx \sqrt{3} \cdot I \cdot R \cdot L$$

%ΔV = ΔV / V_L × 100.

Step-by-step numeric calculations:

A — Lighting

1. **MDB-LC01: 15.0 W, single phase, pf = 0.95, 6 bulbs**

$$I_{light1} = \frac{15 \times 6}{230 \times 0.95} \times 0.9 = 0.3707\ A \approx 0.37\ A$$

2. **MDB-LC02: 15.0 W, single phase, pf = 0.95, 10 bulbs**

$$I_{light2} = \frac{15 \times 10}{230 \times 0.95} \times 0.9 = \ 0.6178\ A \approx 0.62\ A.$$

B — Fans

1. **Ceiling fan: MDB-FAN01- 35.0 W, single phase, pf = 0.7, 8 Fans**

$$I_{light2} = \frac{35 \times 8}{230 \times 0.7} \times 0.9 = \ 1.5652\ A \approx 1.57\ A.$$

C —Power circuits

1. Chillers: MDB/CHI- 1035 W, single phase, pf = 0.7, 8 Fans

$$I_{light2} = \frac{1035 \times 3}{230 \times 0.95} \times 1.0 = \ 14.2105\ A \approx 14.21\ A.$$

Table 1: Quick numeric table

ITEM NO.	Equipment Name	Circuit no		Qty	Demand Factor (ku)	Diversity Factor (ks1)	Unit Capacity					Total demand load in kW	Total demand load in kVA	Elecetrical System	Design current	Design Current (A)				MCB rating
							Rated KW	Effieciency	pf	Input kW	Input kVA					R	Y	B	3 ph	
1	**General lighting Load**																			
		MDB/LC01/R1		6	1.00	0.90	0.015	1.000	0.950	0.02	0.02	0.08	0.09	1	0.37	0.37				6
		MDB/LC02/R2		10	1.00	0.90	0.015	1.000	0.950	0.02	0.02	0.14	0.14	1	0.62	0.62				6
2	**Fans**	MDB/FAN01/R3		8	1.00	0.90	0.035	1.000	0.700	0.04	0.05	0.25	0.36	1	1.57	1.57				6
3	**General Power Load**																			
	Chillers	MDB/CHI/Y1		3	1.00	1.00	1.035	1.000	0.950	1.04	1.09	3.11	3.27	1	14.21		14.21			32
	Freezer	MDB/FRZ/R4		1	1.00	1.00	1.036	1.000	0.750	1.04	1.38	1.04	1.38	1	6.01	6.01				16
	Rice Cooker 1	MDB/RC1/R5		1	1.00	0.80	3.086	1.000	0.990	3.09	3.12	2.47	2.49	1	10.84	10.84				16
	Rice Cooker 2	MDB/RC2/R6		1	1.00	0.80	3.086	1.000	0.990	3.09	3.12	2.47	2.49	1	10.84	10.84				16
	Rice Cooker 3	MDB/RC3/B1		1	1.00	0.80	3.086	1.000	0.990	3.09	3.12	2.47	2.49	1	10.84			10.84		16
	Tea maker	MDB/TM/R7		1	1.00	0.80	1.171	1.000	0.990	1.17	1.18	0.94	0.95	1	4.11	4.11				6
	RO plant	MDB/RO/B2		1	1.00	1.00	4.207	1.000	0.800	4.21	5.26	4.21	5.26	1	22.86			22.86		32
	13 A S/O (Exhaust 2/ spare 4)	MDB/SC1/Y2		6	1.00	1.00	0.300	1.000	0.800	0.30	0.38	1.80	2.25	1	9.78		9.78			16
	13 A S/O (Stand 2/ spare 4)	MDB/SC2/Y3		6	1.00	1.00	0.300	1.000	0.800	0.30	0.38	1.80	2.25	1	9.78		9.87			16
	TOTAL FOR THE DB															**34.36**	**33.86**	**33.7**		
Demand Load, KW												**20.76**								
Demand Load, KVA													**23.42**							
Design current with 10% future expansion A																			**33.81**	

4.CABLE SIZING

Table 2: Cable sizing

Circuit (circuit no.)	Design current (I_d) (A)	Chosen cable (Cu PVC)	(I_z) (A)	Vd (V) at 50 m	Vd % (of 230 V / 400 V)	MCB rating (from sheet)
MDB/LC01 (lighting)	0.37	1.5 mm²	18	0.45 V	0.20%	6 A
MDB/LC02 (lighting)	0.62	1.5 mm²	18	0.75 V	0.33%	6 A
MDB/FAN01 (fans)	1.57	1.5 mm²	18	1.90 V	0.83%	6 A
MDB/CHI (chillers)	14.21	4.0 mm²	36	13.09 V	5.69% → But note below	32 A
MDB/FRZ (freezer)	6.01	2.5 mm²	27	7.25 V	3.15%	16 A
MDB/RC1 (rice cooker 1)	10.82	4.0 mm²	36	11.75 V	5.11%	16 A
MDB/RC2 (rice cooker 2)	10.82	4.0 mm²	36	11.75 V	5.11%	16 A
MDB/RC3 (rice cooker 3)	10.82	4.0 mm²	36	11.75 V	5.11%	16 A
MDB/TM (tea maker)	4.11	1.5 mm² (or 2.5 mm² if socket)	18	2.16 V	0.94%	6 A
MDB/RO (RO plant)	22.86	10.0 mm²	65	21.05 V	9.15%	32 A
MDB/SC1 (13 A S/O Exhaust)	9.78	4.0 mm²	36	11.83 V	5.15%	16 A
MDB/SC2 (13 A S/O Stand)	9.78	4.0 mm²	36	11.83 V	5.15%	16 A
Main feeder	I_line ≈ 33.8 A (3Φ)	10.0 mm²	47	Vd ≈ 9.01 V (≈2.25% of 400V)	2.25% (of 400V)	incomer: 63 A MCCB

5.VOLTAGE DROP

Formulas used

- **Single-phase radial (line and neutral, round trip):**

$$V_d = I \times R_{\Omega/m} \times 2L$$

where III is circuit current, RΩ/mR_{Ω/m}RΩ/m is conductor resistance per metre, L is one-way length (m).

Percentage: $V_d\% = \frac{V_d}{230} \times 100.$

- **Three-phase feeder (line current to line voltage):**

$$V_d = \sqrt{3} \times I_L \times R_{\Omega/m} \times L$$

Percentage: $V_d\% = \frac{V_d}{400} \times 100.$

6.SOCKET OUTLET CIRCUITS

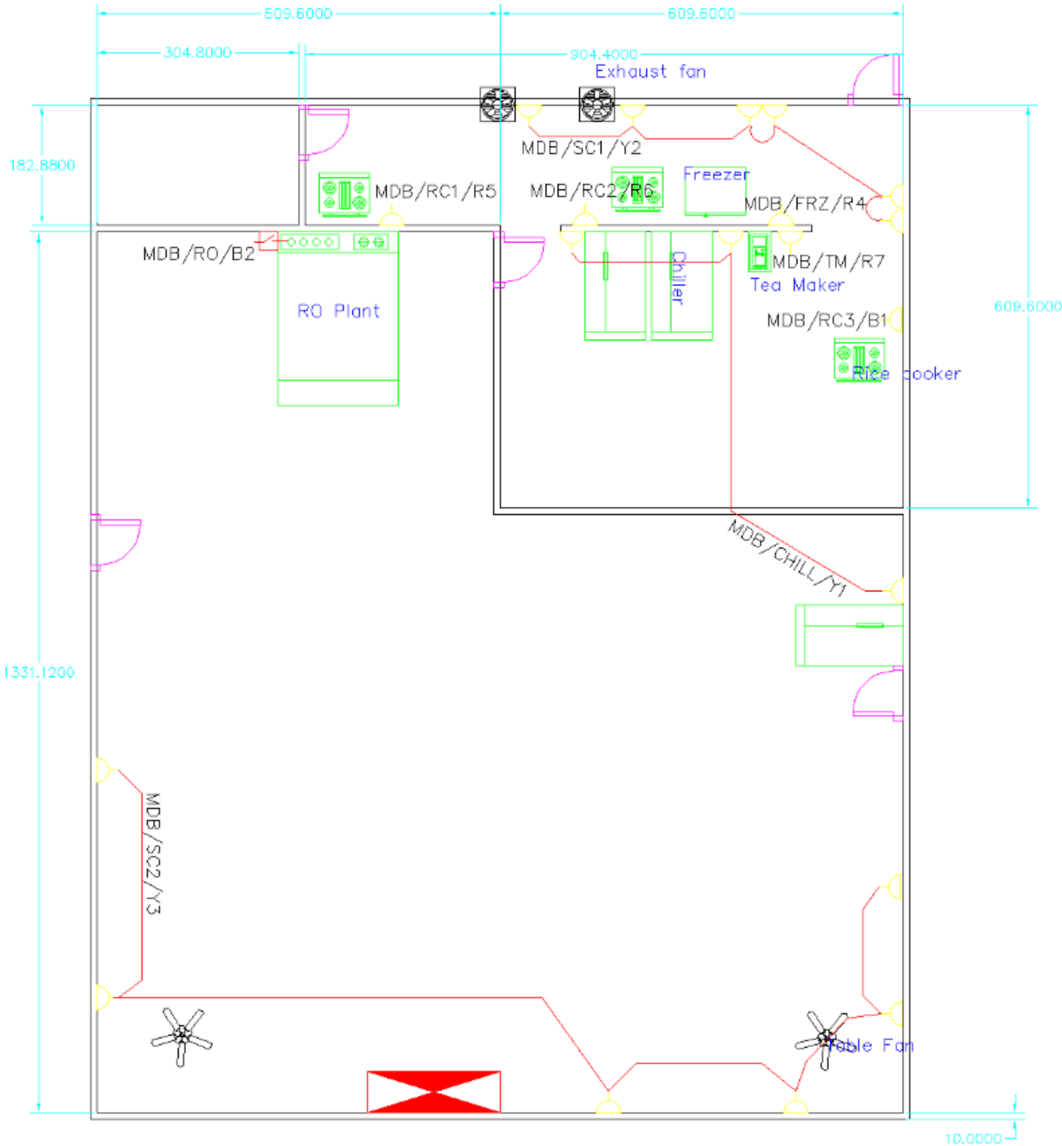

Figure 3:Wirring diagram

7.SUMMARY OF ALL CABLE SIZES AND PROTECTIVE DEVICES

Assumption: All cable length 50 m

Table 3: summery of all cable sizing and protective devices

Circuit (cct no.)	Assigned Phase	Design current (I_d) (A)	cable type (Cu/ PVC/PVC)	Vd (V)	Vd % (of 230 V)	Protective device
General lighting (LC total) (MDB/LC01 + LC02)	R	0.99	1.5 mm²	1.20 V	0.52%	6 A MCB
Fans (MDB/FAN01)	R	1.57	1.5 mm²	1.90 V	0.83%	6 A MCB
Chillers (MDB/CHI)	Y	14.21	4.0 mm²	6.55 V	2.85%	32 A MCB
Freezer (MDB/FRZ)	R	6.01	4.0 mm²	2.77 V	1.20%	16 A MCB
Rice cooker 1 (MDB/RC1)	R	10.84	4.0 mm²	4.99 V	2.17%	16 A MCB
Rice cooker 2 (MDB/RC2)	R	10.84	4.0 mm²	4.99 V	2.17%	16 A MCB
Rice cooker 3 (MDB/RC3)	B	10.84	4.0 mm²	4.99 V	2.17%	16 A MCB
Tea maker (MDB/TM)	R	4.11	1.5 mm²	4.97 V	2.16%	6 A MCB
RO plant (MDB/RO)	B	22.86	10.0 mm²	4.18 V	1.82%	32 A MCB
13 A S/O Exhaust (MDB/SC1)	Y	9.78	4.0 mm²	4.51 V	1.96%	16 A MCB
13 A S/O Stand (MDB/SC2)	Y	9.78	4.0 mm²	4.51 V	1.96%	16 A MCB

Phase	Total design current (A)	After applying safety factor	Suitable protective device
R	34.36	42.95	63 A, 2pole MCB
Y	33.86	42.32	63 A, 2pole MCB
B	33.7	42.12	63 A, 2pole MCB

8.PHASE BALANCING

Table 4: Phase balancing

ITEM NO.	Equipment Name	Circuit no	Design Current (A)		
			R	Y	B
1	**General lighting Load**				
		MDB/LC01/R1	0.37		
		MDB/LC02/R2	0.62		
2	**Fans**	MDB/FAN01/R3	1.57		
3	**General Power Load**				
	Chillers	MDB/CHI/Y1		14.21	
	Freezer	MDB/FRZ/R4	6.01		
	Rice Cooker 1	MDB/RC1/R5	10.84		
	Rice Cooker 2	MDB/RC2/R6	10.84		
	Rice Cooker 3	MDB/RC3/B1			10.84
	Tea maker	MDB/TM/R7	4.11		
	RO plant	MDB/RO/B2			22.86
	13 A S/O (Exhaust 2/ spare 4)	MDB/SC1/Y2		9.78	
	13 A S/O (Stand 2/ spare 4)	MDB/SC2/Y3		9.87	
	TOTAL FOR THE DB		**34.36**	**33.86**	**33.7**

9.MAIN DISTRIBUTION BOARD

The MDB is the primary distribution point that receives the incoming supply from the panel or utility and distributes power safely to sub-circuits (lighting, fans, kitchen equipment, sockets, RO, etc.). It centralizes protection, metering, switching and earthing.

- **Incomer device**
  - ✓ 3-phase MCCB or fused isolator to protect the feeder and provide a visible isolating point..
- **Outgoing circuit breakers**
  - ✓ Individual MCBs/RCDs for each radial; type and curve selected by load (B-curve for lighting/sockets, C/D-curve for motors/chillers with high inrush). Use double-pole or 4-pole devices where required.
- **Residual Current Devices (RCDs) / RCBOs**
  - ✓ For socket groups or general areas, use 30 mA RCDs or RCBOs per final circuit to provide protection against earth leakage.
- **Metering & indicators**
  - ✓ Voltmeter, ammeter (or multifunction meter), phase failure indicator / LED status for quick diagnostics.
- **Surge Protective Device (SPD)**
  - ✓ SPD at the MDB to protect sensitive equipment from transient surges (lightning/electrical switching).
- **Earthing & bonding**
  - ✓ Separate PE termination, earth bar connected to earth electrode; equipotential bonding to metallic structures and water services as per local code.
- **Cable entry & gland plate**
  - ✓ Properly sized cable glands, segregation of power and control cables, and adequate clearance for bending radius.
- **Labels & documentation**
  - ✓ Clear labeling of each outgoing circuit, breaker ratings, cable sizes and circuit destinations. Keep a copy of SLD and cable schedule inside the door.
- **Ventilation & mechanical**
  - ✓ Adequate ventilation or forced air if many heat-producing devices, and mechanical fixing to wall/structure.

10. SINGLE LINE DIAGRAM

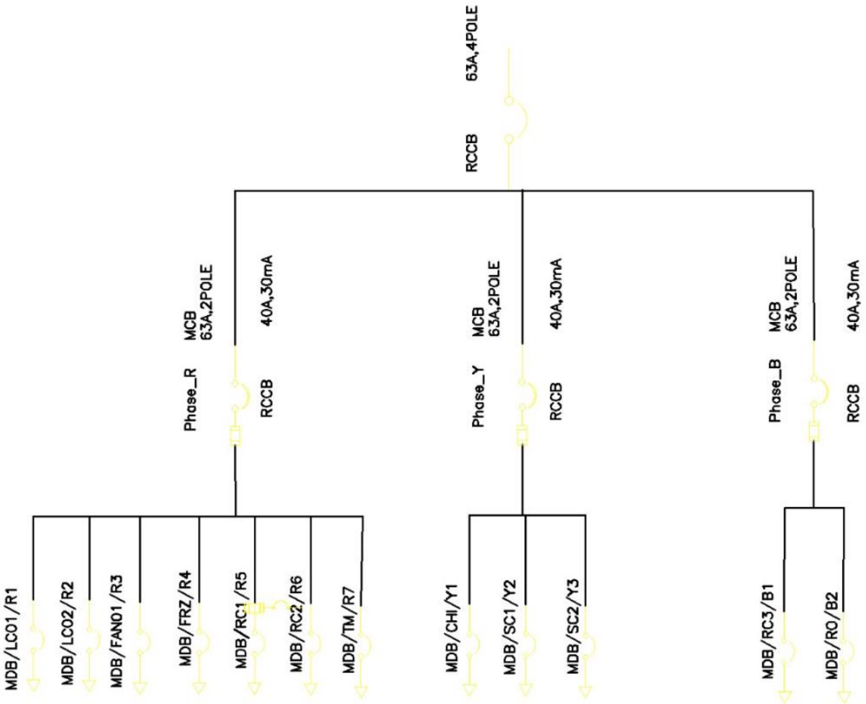

Figure 4: single line diagram

11. CONCLUSION

The electrical installation design for the Engineering Faculty canteen was successfully developed by analyzing the load requirements, selecting suitable protective devices, sizing cables according to References and ensuring compliance with safety and voltage-drop limits. All single-phase and three-phase loads were identified and categorized, and their currents were calculated with respect to the rated power of each appliance. Voltage drop and current-carrying capacity were checked for all circuits over a 50 m supply distance to maintain system efficiency and reliability.

The main feeder from the panel to the canteen was designed as a balanced three-phase system with a load current of approximately 33.8 A. A 6 mm² copper cable was selected as the minimum size based on current rating and voltage drop (2.25% of 400 V), while a 10 mm² cable is recommended where future expansion or lower losses are preferred. For all single-phase circuits, cable sizes were selected such that both ampacity and voltage drop (below 3% of 230 V) were satisfied.

Protective devices such as MCBs and MCCBs were chosen based on load currents, fault levels, and coordination with cable ratings. Phase balancing was carefully performed to distribute loads evenly across phases, minimizing neutral current and increasing overall system stability. Proper earthing, RCD protection, and isolation methods were also incorporated to enhance safety and meet regulatory standards.

Overall, the proposed design ensures:

- Safe operation and protection against overloads, short circuits, and leakage currents
- Acceptable voltage levels at all equipment terminals
- Efficient power distribution with balanced phases and minimal energy loss
- Practical implementation through CAD layout, SLD diagram, and detailed cable schedule

This design meets the technical, safety, and operational requirements of the canteen and serves as a reliable and scalable electrical installation solution.