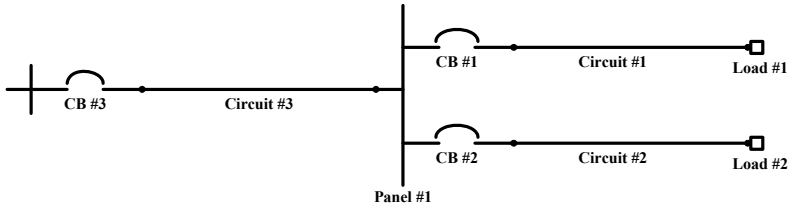
ECET 4520 – Fall 2017 **Lab Assignment #02 - Solutions**

Two loads are served out of Panel #1 by a pair of individual branch circuits, as shown below:



Choose 3+1 individual, THHN, **copper** conductors for each of the circuits. (Do not choose a 3Φ cable)

Load #	Load Ratings	
1	3Φ, 460V, 45kVA, 0.92 lagging p.f.	(continuous)
2	3Φ, 460V, 100kW, unity p.f.	(non-continuous)

PART 1: Determine the magnitude of each load current.

Load#1 = 56 A **Load#2 = 126 A**

$$I_{Line-Rated\,(Load\,\#1)} = \frac{VA_{3\Phi}}{\sqrt{3}\cdot V_{Line-Rated}} = \frac{45{,}000}{\sqrt{3}\cdot 460} = 56.48\text{A} \Rightarrow 56\text{A}$$

$$I_{Line-Rated\,(Load\,\#2)} = \frac{W_{3\Phi}}{\sqrt{3}\cdot V_{Line-Rated}\cdot pf} = \frac{100{,}000}{\sqrt{3}\cdot 460\cdot 1} = 125.51\text{A} \Rightarrow 126\text{A}$$

Article 220.5(B) Calculations – Fractions of an Ampere – Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped.

PART 2: a) Determine the **minimum-sized conductors** and the **smallest standard-sized circuit breaker** for each branch circuit if a separate conduit is used for each circuit and the ambient temp. is 30°C:

Circuit #1: conductor size 4 AWG CB#1 rating 70 A

Determine the minimum required conductor size:

REQUIRED AMPACITY BASED ON CONTINUOUS CURRENT

$$\text{ampacity} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = 1.25 \cdot 56 = 70\text{A}$$

REQUIRED AMPACITY BASED ON ADJUSTMENT FACTORS

$$\text{ampacity} \geq \frac{I_{actual}}{\text{adjustment factors}} = \frac{56}{(1)\cdot(1)} = 56\text{A}$$

Choose the larger of the two cases.

Since the circuit will be rated ≤100A, apply a 60°C temperature rating to the conductors.

Based on Table 310.15(B)(16) – **4 AWG** copper with a 60°C rating has an ampacity of **70A**

Determine the minimum circuit breaker size:

$$CB_{rating} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = 1.25 \cdot 56 = 70\text{A}$$

Thus, choose a **70A** circuit breaker.

Circuit #2: conductor size 1 AWG CB#2 rating 150 A

Minimum required conductor size:

ampacity ≥ 126A Since the circuit will be rated >100A, apply a conductor 75°C temp. rating.

Based on Table 310.15(B)(16) – **1 AWG** copper with a 75°C rating has an ampacity of **130A**

Determine the minimum circuit breaker size:

$CB_{rating} \geq 126\text{A}$ Choose a **150A** circuit breaker. ***240.4(B)*** *allows next higher CB above ampacity.*

PART 2: **b)** Assuming that (feeder) circuit #3 must serve both loads, determine the minimum-sized conductors and the smallest standard-sized circuit breaker that can be used for circuit #3:

Circuit #3: conductor size 3/0 AWG CB#2 rating 200 A

Determine the minimum required conductor size:

REQUIRED AMPACITY BASED ON CONTINUOUS CURRENT

$$\text{ampacity} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = (126) + (1.25 \cdot 56) = 196\text{A}$$

REQUIRED AMPACITY BASED ON ADJUSTMENT FACTORS

$$\text{ampacity} \geq \frac{I_{actual}}{\text{adjustment factors}} = \frac{126 + 56}{(1) \cdot (1)} = 182\text{A}$$

Since the circuit will be rated >100A, apply a 75°C temperature rating to the conductors.

Based on Table 310.15(B)(16) – **3/0 AWG** copper with a 75°C rating has an ampacity of **200A**

Determine the minimum circuit breaker size:

$$CB_{rating} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = (126) + (1.25 \cdot 56) = 196\text{A}$$

Thus, choose a **200A** circuit breaker.

PART 3: Repeat the steps specified in Part 2 (**a**) and (**b**), but with the following system changes:
i) The conductors for circuits (#1 and #2) are in the same conduit (i.e. – 6 conductors in raceway), and
ii) The ambient temperature is 38°C:

Circuit #1: conductor size 3 AWG CB#1 rating 70 A

$$\text{ampacity} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = 1.25 \cdot 56 = 70\text{A}$$

$$\text{ampacity} \geq \frac{I_{actual}}{\text{adjustment factors}} = \frac{56}{(0.8) \cdot (0.82)} = 85\text{A}$$

3 AWG copper with a 60°C rating has an ampacity of **85A**

$CB_{rating} \geq 1.25 \cdot 56 = 70\text{A}$ Choose a **70A** circuit breaker.

Based on Table 310.15(B)(3)(a): 4-6 cond. in raceway **0.80 Adj. Factor**

Based on Table 310.15(B)(2)(a): 38°C Ambient Temp. with 60°C Temp. Rating **0.82 Adj. Factor**

Circuit #2: conductor size 3/0 AWG CB#1 rating 150 A

$$\text{ampacity} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = 1 \cdot 126 = 126\text{A}$$

$$\text{ampacity} \geq \frac{I_{actual}}{\text{adjustment factors}} = \frac{126}{(0.8) \cdot (0.82)} = 192\text{A}$$

Based on Table 310.15(B)(16) – **3/0 AWG** copper with a 75°C rating has an ampacity of **200A**

$CB_{rating} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = 1 \cdot 126 = 126\text{A}$ Choose a **150A** circuit breaker.

Circuit #3: conductor size 4/0 AWG CB#1 rating 200 A

$$\text{ampacity} \geq 100\% \cdot I_{non-continuous} + 125\% \cdot I_{continuous} = (126) + (1.25 \cdot 56) = 196\text{A}$$

$$\text{ampacity} \geq \frac{I_{actual}}{\text{adjustment factors}} = \frac{126 + 56}{(0.8) \cdot (1)} = 228\text{A}$$

Only the Ambient Temp. factor applies to Circuit #3 since it doesn't share a conduit.

Based on Table 310.15(B)(16) – **4/0 AWG** copper with a 75°C rating has an ampacity of **230A**

$\text{ampacity} \geq (126) + (1.25 \cdot 56) = 196\text{A}$ Choose a **200A** circuit breaker.