ECET 4520 – Fall 2014
Exam II – Part A **Print Name (Last Name First):** KEY

Instructions: This exam is closed book except for the reference booklet and one 8.5″x11″ sheet of notes.

Assume an *ambient temperature of 30°C* if needed for all problems unless stated otherwise.

Problem #1) A three-phase, 208V branch circuit is serving a load that consumes both a continuous and a non-continuous amount of power as follows:

Load Ratings: 200V, 3Φ 25KVA, pf = 0.85 lagging, (continuous operation) 72.2A × 1.25 = 90.2A
20KVA, pf = 0.85 lagging, (non-continuous operation) 57.7A

∴ 90A adj cont
58A nc

a) Determine the ***smallest, standard-sized circuit breaker*** that can be used to protect this circuit.

~148A adjusted → 150A CB

CB rating = 150 A

b) Specify the ***temperature rating*** that should be applied to the conductors of this branch circuit based upon the rating of the load that it is serving. Justify your answer.

> 100A ∴ 75°C

Temp rating = 75° °C

Justify your answer in the space below:

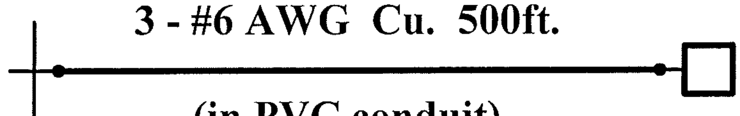
c) Specify the ***smallest allowable size*** THHN, copper conductors that can be utilized for this branch circuit assuming that the circuit is composed of three, individual conductors that are run through aluminum conduit, that the ambient temperature is 30°C, and that no other current-carrying conductors are run in the same conduit with this branch circuit.

Cu 1/0 75°C → 150A
no adjustments

Conductor Size = 1/0

Problem #2) Given a 3Φ, 208V branch circuit that consists of three individual, 500' long, #6 AWG, THHN, copper conductors (as shown in the figure below):

3 - #6 AWG Cu. 500ft.



(in PVC conduit)

Need to account for

If the load supplied by the branch circuit is a continuous load that is rated at ***200V***, ***15kVA*** and it operates with a power factor ***pf = 0.85 lagging***, 43.3A ~ 43A actual ← 60°C Rating

a) Determine the ***voltage-drop*** that will occur across this branch circuit, in terms of the circuit's line-voltage, under rated-load conditions.

$R_{75} = 0.49$
$R_{60} = 0.49(1 - 0.00323(60-75))$
$= 0.466$

$Z_c = (0.466)(0.85) + (0.051)(0.527) = 0.423\ \Omega/1000'$

$V_{drop} = \sqrt{3} \cdot 43 \cdot (0.423)\left(\frac{500}{1000}\right) = 15.75\ V_{line}$

$\frac{15.75}{208} \times 100 = 7.6\%$

$V_{drop(Line)}$ = 15.75 V

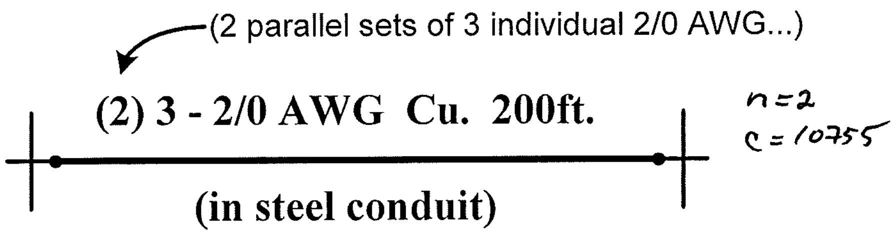
b) Does the voltage-drop calculated in part (a) fall under ***acceptable standards*** as defined by the NEC? Justify/explain your answer:

Circle your answer → Yes / **(No)**
(Explain in the space below)

Both larger than 5% Total max
+ 3% BC drop max

Problem #3) Given a 3Φ feeder circuit that is composed of two parallel sets of 200' long, 2/0 AWG, THHN, copper conductors (as shown in the figure below):

Need $V_{rated} = 480V$ ✓



If the L-L-L short-circuit current available at the "source-end" of the circuit is 12,000A

Determine the 3Φ, L-L-L ***short circuit current*** available at "load-end" of the 200' circuit using the point-to-point method of calculation.

$$f = \frac{\sqrt{3}(200')(12000A)}{(10755)(2)(480)} = 0.4026$$

$$m = \frac{1}{1+0.4026} = 0.713 \qquad I = (12000)(0.713) = 8555A$$

$I_{SCA(Load-End)} =$ 8555 **amps**

Problem #4) Given a 480V, 3Φ branch circuit that consists of three individual, 350kcmil, THHN, ***aluminum conductors*** fed that are fed through a steel conduit.

Determine the ***AC resistance*** and ***reactance*** of the conductors per 1000' assuming an operational temperature of 90°C.

$$R_{75} = 0.063 \qquad R_{90} = 0.063(1+0.00330(90-75)) = 0.063(1.0495) = 0.06612\ \Omega/\text{kft}$$

$R_{AC} =$ 0.0661 **Ω/1000'**

$$X_L = 0.050$$

$X_L =$ 0.050 **Ω/1000'**

Problem #5) Given a 3Φ, 112.5kVA, 13.8kV– 480V, Y-Y "step-down" transformer that provides service to an industrial building;

a) Determine the ***rated phase-voltage*** for the transformer's secondary winding.

$$I_{R,480} = \frac{112500}{\sqrt{3}(480)} = 135.3 \sim 135A \qquad V_{pl} = \frac{480}{\sqrt{3}} = 277.1V$$

$V_{Phase(rated)SECONDARY} =$ 277 **V**

b) Determine the ***rated line-current*** for the transformer's primary and secondary windings.

$$I_{R,13.8k} = \frac{112500}{\sqrt{3}(13800)} = 4.71A$$

$I_{Line(rated)PRIMARY} =$ 4.71 **A**

$I_{Line(rated)SECONDARY} =$ 135 **A**

c) Assuming that an "infinite bus" supplies the transformer's primary windings, determine the L-L-L ***short-circuit current*** available at the secondary terminals of the transformer.

Note – use "Table 1.2 – Impedance Data for 3Φ Transformers" that is provided in the reference booklet in order to get impedance information for this transformer.

$$112.5\text{kVA} \quad 1\%Z \qquad m = \frac{100\%}{\%Z} = \frac{100}{1} = 100$$

$$I_{SCA} = I_{R_{480}} \cdot m = (135.3)\left(\frac{100\%}{1\%}\right) = 13530A$$

$I_{SCA(Sec)} =$ 13530 **A**

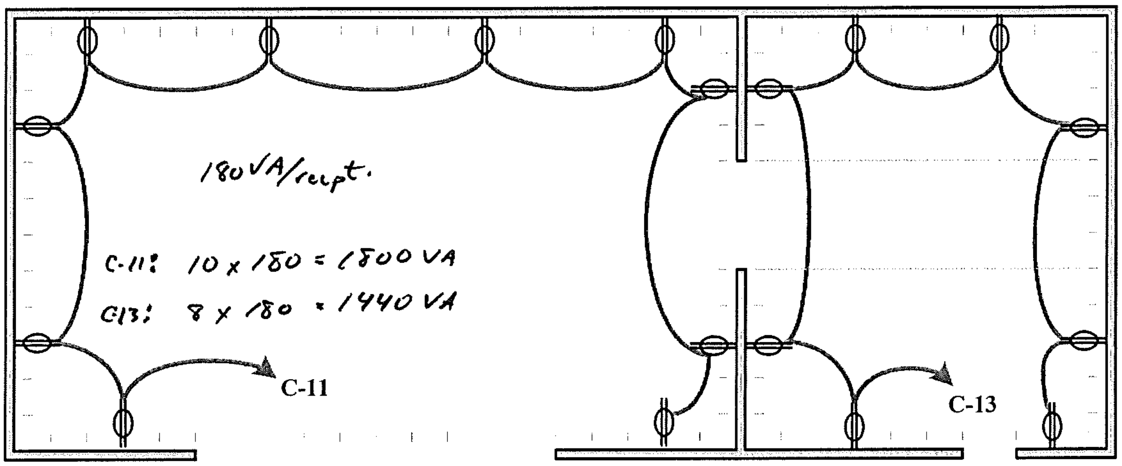
Problem #6) Given a raceway that contains three different, 3Φ, 3-wire (current-carrying) circuits, each of which are composed of three individual, #4 AWG, THHN, copper conductors. Determine the effective **ampacity** of the conductors if they have an operational temperature rating of 60°C and the ambient temperature is 42°C.

9 conductors – 70%   42°C Amb – 0.71

#4 THHN Cu 60°C → 70A × (0.7) × (0.71) = 34.8 ~ 35A

Ampacity = 35 **A**

Problem #7) The following figure shows the (120V, 1Φ) general purpose receptacles located within two rooms of a dwelling unit along with the circuits to which they are connected.



Based on NEC guidelines, determine the ***minimum load rating*** that can be applied to the circuits.

C – 11 Load Rating = 1800 **VA**

C – 13 Load Rating = 1440 **VA**

Problem #8) Specify if each statement is True or False based on NEC guidelines and/or standard design practice

FALSE — Given a branch circuit that utilizes copper conductors, the **ampacity** of the conductors can be increased by switching from copper to aluminum without changing conductor size

FALSE — Increasing the length of a conductor will cause its **ampacity** to decrease.

TRUE — The **overcurrent protection device** protecting a branch circuit should always be placed at the "service-end" of the circuit conductors.

FALSE — Both **THHN-type** and **TW-type** (← 60°C rated) conductors can be used as the circuit conductors in circuits having a 60°C, 75°C or 90°C temperature rating.

TRUE — An "**overload**" current refers to any larger than rated current that flows along the normally conductive paths of a circuit.

_____ — A "**branch-circuit**" consists of a set of conductors that carry all of the currents that flow into the individual load branches served by a specific panelboard.

FALSE — The "**interrupting rating**" of an circuit breaker is the magnitude of the continuous circuit current above which will cause the circuit breaker to trip.