ECE215/S – Principles of Electronic Cyber Warfare
Project 1 - Fall 2026 - Power Distribution Document 1 of 2

This is a **group project** to be completed in teams of **2-4 cadets**. Review the course policies in your ECE215/S syllabus regarding absences, collaboration, and documentation.

The Mission. Your team will perform tasks on both sides of the contracting process. In **Part 1** of the project, you will play the role of contractors trying to meet (or exceed!) the requirements set by the government for a power system of a classified prototype aerial platform. **You want to have a better system design than the other contractors!** In **Part 2** of the project, you will shift to the role of government evaluators tasked with analyzing and objectively rating contract proposals.

The Part 2 packet — the competing contractor proposals — is posted on the Project 1 page of the course website, **password-protected**: turn in Submission 1 on Gradescope and your results will show the password. **No team sees another design before its own is submitted.**

System Requirements. The power system for the prototype platform must properly energize the following eight primary electrical loads with the following requirements (assume that all AC voltages are in RMS and apply for a 60Hz system). For simplicity, these loads are labeled A-H on the provided proposal diagrams. In your design, you should also label the loads accordingly.

Load	Description	Voltage	Load Specifications
A	Recirculation fans	$240V_{rms}$	8kW, pf = 0.8 lagging
B	Fuel Pumps	$240V_{rms}$	12kVA, pf = 0.6 lagging
C	Cabin lighting	$120V_{rms}$	6kW, pf = 0.8 lagging
D	Cabin fans	$120V_{rms}$	5 hp, $\eta = 88.89\%$, pf = 0.8 lagging
E	Auto-Pilot & Controls	48VDC	R = 2Ω
F	Brake Power	48VDC	0.75 hp, $\eta = 85\%$
G	Communications	24VDC	500W
H	Flight Displays	24VDC	25A

Table 1: System Load Requirements

Proposed systems must comply with all of the following:

- All loads must be connected to a bus and powered to the specifications listed in Table 1.
- The system must be powered by a generator **not to exceed the rated real power of** 30**kW** during normal operation. The generator should be *attached* to either a $240V_{rms}$ or $120V_{rms}$ bus.
- A resistor between $0.016\Omega - 0.022\Omega$ **must** be included between the generator and the first bus to capture the effects of wiring losses. No cost is associated with this resistor.
- Besides the aforementioned generator and resistor, the system must only use the commercial off the shelf (COTS) converters listed in Table 2.
- All loads, buses, and power conversion equipment must be protected from abnormally high currents. Each piece of equipment will therefore have its own circuit breaker — see **Circuit Breakers**, below.
- The system cost due to power conversion and circuit protection must not exceed $500,000.
- The volume of power conversion equipment must not exceed $25m^3$.

How Your Design Will Be Evaluated. The requirements above are pass/fail: a design that violates any one of them is non-compliant, not merely a weaker design. Among compliant designs, the government will score as follows:

- Preference will be given to systems that demonstrate optimized Size, Weight, and Power (SWaP) characteristics while meeting or exceeding performance and operational requirements. Offerors are encouraged to minimize cost and physical size of the system while maximizing system power efficiency.
- Cost will be weighted 2x efficiency, and efficiency will be weighted 2x volume.

COTS Power Converters. Any combination of the converters listed in the following table, in any quantity, is available for system designs — a catalog item may be used more than once, and each instance is priced and counted separately. **You must attach a converter's input and output to a bus. Each converter has only one input and one output.**

Item	Type	Description	Cost	Volume
Converter 1	AC/DC	$\eta = 90\%$, pf $= 0.9$ lag	\$100k	1.000m^3
Converter 2	AC/DC	$\eta = 80\%$, pf $= 0.8$ lag	\$87.5k	0.875m^3
Converter 3	AC/AC	$a = 2.0$	\$60k	8.000m^3
Converter 4	AC/AC	$a = 2.0$	\$45k	6.000m^3
Converter 5	AC/AC	$a = 0.5$	\$60k	8.000m^3
Converter 6	DC/DC	$\eta = 92\%$	\$36k	0.900m^3
Converter 7	DC/DC	$\eta = 85\%$	\$45k	1.125m^3
Converter 8	DC/AC	$\eta = 82\%$	\$115k	9.000m^3
Converter 9	DC/AC	$\eta = 75\%$	\$105k	9.500m^3

Table 2: COTS converters available for system design

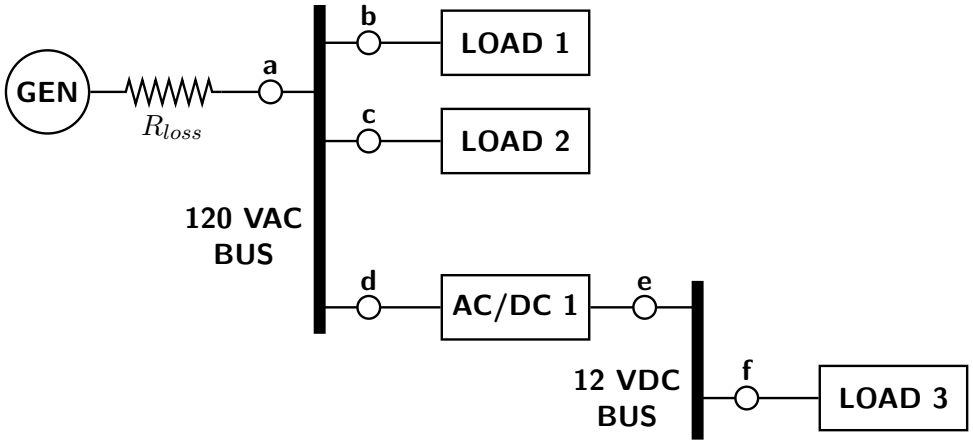
Note: You may **not** use a resistive voltage divider in place of power converters.

Circuit Breakers. Every load, every bus, and every piece of power conversion equipment gets its own circuit breaker. Draw each circuit breaker as a **small, inline circle** immediately before the equipment it protects and label it with a letter; list each breaker's current rating on the diagram or in a small ratings table, as in Figure 1. The cost of each circuit breaker depends on its rated current:

CB Ratings	Cost per CB
10, 15, 18, 20, 30, 35, 40, 50	\$700
60, 70, 80, 100	\$1,000
120, 180, 200	\$2,000

Table 3: Circuit breakers available for system design

Drawing Your Design. Your block diagram must be **easy to read, clearly labeled**, and drawn using the conventions shown in Figure 1. A grader who cannot follow your diagram cannot award the point for it.



CB	Rating
a	60A
b	20A
c	30A
d	30A
e	100A
f	40A

Figure 1: Drawing conventions only — **this toy two-bus system is not a valid Project 1 design.** It shows how each element is drawn: the generator as a labeled circle, R_{loss} as a zigzag, each bus as a heavy bar, each circuit breaker as a small lettered circle with its rating in the table alongside, and each load and converter as a labeled box. Your own diagram must label every bus and its voltage, every circuit breaker with its letter and rating (on the diagram or in a table), every load A-H, every converter, R_{loss}, and the generator.

Deliverables. This project will be submitted, graded, and returned via three Gradescope submissions. Each submission is worth 1 point. This project will utilize specifications-based grading. You can find more details on the scoring mechanism in your syllabus. **Gradescope is authoritative for all deadlines.**

Submission 1 — system design. *Group submission* of **two files** — your design and analysis as a **PDF**, and the completed **Design Summary workbook** (template on the course website) — due **Monday 14 September at 2359** (before Lesson 14). To earn a 1, you must meet the following specifications:

- ☐ System design is easy to read, clearly labeled, meets all design requirements, and follows the conventions of Figure 1.
- ☐ Mathematical analysis is provided, easy to read, and clearly labeled. It must include the required computations listed below.

Gradescope's automatic consistency report on your workbook is **advisory feedback only** — your instructors grade the two specifications above.

Required Computations. In addition to your system design block diagram, Submission 1 must provide the following computations assessing your system efficiency, cost, and volume:

- Currents through all circuit breakers
- Total real power to the 8 loads (useful power)
- Total real power the generator must supply
- Total system real power losses
- Efficiency (η) of the system design
- Total cost of the system design
- Total power converter volume in the design

Submission 2 — decision matrix. *Group submission* of an unbiased assessment utilizing a decision matrix, due **Wednesday 16 September at 2359**. To earn a 1, you must meet the following specifications:

- ☐ Decision Matrix is filled out correctly. This will be auto-graded and therefore trivial math errors *will not* receive credit. Rounding errors will be okay.

☐ Mathematical analysis behind decision matrix is provided, easy to read, and clearly labeled. This can be clearly labeled hand-written notes or a well-organized spreadsheet.

Submission 3 — engineering analysis. *Individual submission* of *individual effort* questions regarding your engineering analysis of the designs, due **Wednesday 16 September at 2359**. To earn a 1, you must meet the following specification:

☐ Questions are answered correctly with *concise* technical writing. Lengthy responses *will not* receive credit.

Tips and Tricks.

As you build your design and perform your analysis, here are some things to consider:

- Your design needs **both AC and DC buses**. Build around the voltages your loads use — $24V_{DC}$, $48V_{DC}$, $120V_{rms}$, $240V_{rms}$ — making one the primary bus fed by the generator and reaching the rest through converters. Your buses must match Table 1's load voltages; Figure 1's 12 VDC bus is deliberately *not* one of them — it shows conventions only.
- Assume the power converters are designed to be compatible with any of the connected buses, meaning the same AC and DC specifications apply regardless of input and output voltages.
- If you place the generator on the far left side of your design, you will want to perform computations from right to left.
- Find the rated current, real power, and reactive power (if AC) for each of the eight loads. The useful power, or P_{out}, is the sum of the individual load *real* powers. For loads with mechanical power outputs, **use the electrical input power, *not the mechanical output power***, for calculating the system useful power, P_{out}.
- For DC buses, voltage and current remain in phase and there is no need to consider apparent power in your current computations. For AC buses, voltage and current may be out of phase and you will need to consider apparent power.
- Use the output real power and efficiency of converters to get the input real power. For AC/DC converters, you will then need to use the power factor to find the apparent power for the AC side of the converter.
- A decision matrix over your own candidate designs identifies your best option — the one most likely to win the contract against the **two** competing contractor designs you have not seen.
- **A spreadsheet can automate some of the required computations, helping you expedite your design and analysis and reduce math errors.**

Ground Rules.

For this project, you are authorized to use the following resources:

- Calculator and/or computational programs, such as Excel, MATLAB, Google Sheets, Python.
- ECE 215 equation sheet
- Slides and class notes
- Reading provided on 215/S course website or otherwise by your instructors
- Practice Problems
- **Level 2** use of GenAI (see AW GenAI policy)

In addition to authorized resources, you are permitted to work with the cadets *in your project group* and to seek extra instruction (EI) from instructors.

Note on EI from ECE 315 instructors: this project has differences in power computations from those of the ECE 315 Project 1.