

**University of Pittsburgh at Johnstown**  
**Department of Electrical and Computer Engineering**

**COE/EE 1195**  
**Engineering Practice (Design) and Professional Development**  
**“Project Proposal” Course**

**PRIMER: Step 5: The FINAL DESIGN (WRITTEN)**

## **Background**

It is required for project managers (i.e. STUDENTS) to complete their project DESIGN by the conclusion of COE/1195 semester. This document provides the necessary background information to complete “FINAL DESIGN (written)” submission. This is the culmination of the COE/EE1195 Sr. Project Proposal, and is generally due at the end of semester.

## **Grade Value**

The FINAL PAPER DESIGN comprises 20% of the EE/COE 1195 grade. 15% for the written submission (Project Logbook and Project Binder). 5% for the Oral Presentation of the Final Design.

## **Guidance:**

The FINAL PAPER DESIGN is not an individual report, rather a compilation of the entire semester’s work. The submission is your PROJECT LOGBOOK and PROJECT BINDER. **Generally, given the Project Binder and Logbook, a different project team could successfully continue the Project** (by starting the build with your FINAL DESIGN and bill of materials (BOM), and referring to your Time Schedule – Task Division, Block Diagram, Engineering Specifications, etc.). Guidance on these items can be found in the latest revision of the “1195\_1199 Sr Project Proposal Sr Proj Guidelines” document, and, for convenience, pertinent sections included with this document.

Per ABET, **Engineering design involves “identifying opportunities, developing requirements, performing analysis and synthesis, generating multiple solutions, evaluating solutions against requirements, considering risks, and making trade- offs, for the purpose of obtaining a high-quality solution under the given circumstances”.** **The composite FINAL PROJECT BINDER / LOGBOOK (in its entirety) should reflect this general statement.**

## **Required Sections:**

### **1. PROJECT BINDER**

Focus will be on the following section: **TAB: Design Schematics, Drawings, and Bill of Material (BOM)**

**Design schematics. The drawing (or set of drawings) must have all pertinent information so that the circuit can be assembled directly from the schematic(s).** This is a very detailed / updated expansion of your Block Diagram. All part numbers, pin numbers (pinouts), power and ground connections, component values, etc. must be on the drawing), calculations for circuit designs, and data sheets for all components used in the design present. If a component value was assumed to begin the design, please state this in the design calculations. This information, depending on the size of the project, may be in the Project Journal (Logbook), but will likely require schematics, neatly organized in the Project Binder. When using larger paper (‘B’, ‘C’, or ‘D’ size), be sure to fold correctly and place in to Binder. Most micro-controllers / IC chips have a base pinout drawing available to incorporate in to the drawing.

With design calculations, show the original equation using labels for the components (i.e. R1, C2, L1) the equation with the numerical values and units, and then the final answer. The answer should be boxed in

so that the answers are easily identified. Any data, graphs, plots, etc. that were initially required to complete the design must be included. For software-centric projects, the Flowchart should be very detailed and complete. Use larger paper, or proper flowchart symbol page extenders as needed. Include any small sections of code or functions that were built / tested.

A parts list including quantity, part number, description, manufacturer, vendor and price for each item must be included. This is considered a Bill of Materials (BOM). The BOM is a listing of the materials and parts used to build your product. Each material in the list should include the quantity needed and a unique part number that can be used to identify the exact part or material to acquire from the supplier. Additional information (such as the cost, description, revision history, photos, and supplementary characteristics) may be included with your BOM, or that information may be available elsewhere (using the unique part number as the reference). For complex projects, some of the parts listed in a BOM may be sub-assemblies (that each have their own BOM). **Include, at a minimum, the product brochure, data / specification sheet, or similar documentation from the manufacturer. ALSO, the assembly diagram (block diagram, schematic, etc.) MUST reference the BOM.** *(note: often, applicable codes / standards are also found on the mfr's cut sheet)*

Accompanying the parts list, (BOM), identification of the applicable codes and/or standards the component / assembly satisfies must be present. For example, if the project requires an enclosure "constructed for either indoor or outdoor used to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by external formation of ice on the enclosure", the applicable standard would be NEMA 3R or IP14. Similarly, if the project uses a wireless data transfer, list the applicable wireless data standards, with a brief description (there are numerous wireless data technologies and standards exist, for example, the IEEE's set of 802.11 wireless standards). Consider a project featuring an industrial control panel should be designed and built in accordance with the National Electrical Code (NEC), (also known as National Fire Protection Agency (NFPA) 70) standard). The NEC is the widely-accepted standard, and the benchmark for safe electrical design, installation, and inspection to protect people and property from electrical hazards. NEC Article 409 covers industrial control panels, applies to panels intended for general use at 600 volts or less, in ordinary locations.

All materials / products adhere to some type of code / standard, not just the technological advanced features / components. Consider a glove, will the ingredients in the glove cause allergies, is it safe for handling food? (Reference applicable ASTM (American Society for Testing and Materials) standard, there are over 12,000 ASTM standards globally). Pesticides must adhere to US Environmental Protection Agency (EPA) standards. Pet Food is regulated by the US Food and Drug Administration (FDA) and the Department of Agriculture (or equivalent department) in each State. Codes and standards aim to improve the lives of millions, and make the world a better place to live. Standards cover a wide range of subjects from skyscraper construction to nanotechnology, from footballs to swimsuits. Standards can be very specific, such as to a particular type of product, or general such as management practices. Often, multiple standards apply. As an example, search "Toy Safety" online.

**It is the Project Teams responsibility to research applicable codes and standards for their project, and address these in the FINAL DESIGN, and subsequently, during the building / prototyping during the follow-on semester build.**

Succinctly, the “FINAL DESIGN” tab should contain the above information / material (as it applies to the specific project). Given this tab, and all of its contents, could another project team build the project? Some of the information is **updated** carryover from previous submissions (e.g. flowcharts, block diagrams, sketches), relevant information from the project logbook, and select manufacturer’s data. The remaining information (in the “FINAL DESIGN” tab) is new (e.g. BOMs, cut sheets, preliminary code, applicable code references, assembly drawings, etc.). There is no “one size fits all” example to the FINAL DESIGN tab. Due to the wide variety of projects, software, hardware, machine, etc., the FINAL DESIGN is unique. In all cases, the information must be neat, organized, and presented in an efficient and sensible manner.

## **2. PROJECT LOGBOOK**

Each time the student works on their senior project, an entry must be made in the personal project logbook. The entry is a brief description of the work that was done during that session. It must answer the questions who, what, when, where and why! The time spent rounded off to the nearest 15 minutes should be indicated so that when the project is over the accumulated time for the entire project can be calculated.

Be diligent entering time / work in the Project Logbook. The Logbook is not just a “diary”, it should include preliminary designs, sketches, ideas, thoughts, code functions, drawings, questions, etc. The logbook is not merely a record of time, it is the raw “heart and soul” of the project (compared to the Binder, which is a detailed compilation of vetted / final submissions / documents, the Binder is very neat and organized...).

The project log should contain a record of all significant work done on the project. **It should include calculations, sketches, diagrams, test results and data, etc.** The entries in the log can be in any form; however, a good rule-of-thumb to follow might be to put the entries in such a form that five years from now the writer could refer to the entry and would have no difficulty in deciphering what it signifies! In industry, the project log is a very important part of the record of the project. In the event a certain design is considered patentable, a dated record and signed page in the project log will establish the actual date that the idea was conceived. If two companies claim legal rights to the design, the courts should use the data log to establish who had prior knowledge of the design. If it becomes necessary for a company to defend against a project safety suit, the project log will help establish any considerations given to consumer safety. Therefore, date and sign each page in ink!