Electronics Assembly for Engineers
SYLLABUS

The Electronics Assembly for Engineers course introduces the key tools, materials, and processes for engineers working in electronics assembly. This course is designed to encompass the entire assembly process, including a selection of Modules to address the current needs and future goals of engineers and organizations.

COURSE OBJECTIVE

After completing this course, you will be able to employ the key tools, materials, and processes required for engineers to build Printed Circuit Board Assemblies (PCAs) within an electronics manufacturing facility.

LEARNING OBJECTIVES PER COURSE MODULE

MODULE 1: INTRODUCTION TO THE ELECTRONICS INDUSTRY

- Explain the difference between electronics products in Class 1, 2, and 3
- Describe the role of IPC standards within the electronic manufacturing industry
- Describe the topics covered by common IPC standards
- Explain the focus and function of IPC training and certification programs

MODULE 2: INTRODUCTION TO PRINTED CIRCUIT BOARD (PCB)

- Describe the assembly process of a Printed Circuit Board (PCB)
- Identify the common components of a Printed Circuit Board (PCB)

MODULE 3: INTRODUCTION TO PRINTED CIRCUIT ASSEMBLY (PCA)

- Identify the common components of a Printed Circuit Assembly (PCA)
- Describe the different attachment methods used in printed circuit assembly

MODULE 4: COMPONENT IDENTIFICATION

- Identify types of components used in electronic assemblies
- Explain how component reference designators are used to locate components on a PCB
- Distinguish between component polarity and orientation
- Differentiate between wires, cables, and harnesses
- Identify types of terminals used in electronic assemblies
- Identify types of hardware used in electronic assemblies

MODULE 5: ENGINEERING DOCUMENTATION & MEASUREMENT

- Differentiate types of documentation used in electronics assembly
- Explain how engineering drawings are used as a build reference

- Describe the relationship between engineering drawings and work instructions
- Identify the components of a Bill of Materials (BOM)
- Identify common measurement tools used in the assembly process

MODULE 6: INTRODUCTION TO HAND SOLDERING

- Use quality condition criteria to determine component acceptability
- Explain the function of common hand soldering tools, equipment, and materials
- Identify best practices and methods for hand soldering
- Identify common hand soldering defects and soldering anomalies

MODULE 7: SURFACE MOUNT TECHNOLOGY

- Describe the assembly process of Surface Mount Technology (SMT)
- Identify tools and materials used in surface mount technology (SMT) assembly process
- Describe steps in surface mount technology (SMT) assembly process
- Define the reflow soldering process for SMT assemblies
- Identify the cause and types of SMT defects within the soldering process

MODULE 8: THROUGH-HOLE TECHNOLOGY

- Describe the assembly process of through-hole (TH) Technology
- Describe the process and properties of through-hole (TH) technology
- Identify common through-hole insertion methods, tools, and machines
- Identify common through-hole assembly defects

MODULE 9: WIRE, CABLE, AND HARNESS TECHNOLOGY

- Identify characteristics of wire and cables used in electronics industry
- Recognize steps in wire preparation
- Identify inspection criteria for cutting, stripping, and tinning wire
- Identify types of wire terminations
- Differentiate between methods of connecting wires to terminals
- Differentiate between acceptable and defect soldered and crimped terminations
- Identify types of connectors used in wire harness technology
- Distinguish methods of connectorization
- Distinguish methods for making and evaluating wire splices
- Describe the wire harness assembly process

MODULE 10: CONFORMAL COATING

- Identify equipment, tools, and materials used in conformal coating
- Explain steps in conformal coating process
- Classify causes and characteristics of conformal coating defects

MODULE 11: HARDWARE

- Identify tools used in electronics assembly
- Recognize hardware and other materials used in electronics assembly
- Differentiate between acceptable and defect conditions of installed hardware and materials

MODULE 12: QUALITY ASSURANCE

- Define quality in electronics manufacturing
- Identify tools used for PCB and PCA inspection
- Recall different quality conditions specified in IPC-A-610 and IPC-A-600
- Identify PCB and PCA defects according to IPC standards

FINAL EXAM

Participants must complete the Final Exam with a passing score of 80% to access and download their Electronics Assembly for Engineers Certificate. Students may attempt the exam up to three (3) times. Please note that a third and final attempt is permitted after 24 hours of the second attempt.

COURSE RESOURCES

Everything you need to successfully complete the Electronics Assembly for Engineers course is included and available on the IPC EDGE Learning Management System.

MODULE COMPONENTS AND REQUIREMENTS

The Electronics Assembly for Engineers program provides engaging videos, activities, and quizzes designed to help you learn, remember, and apply the knowledge and skills you will need to excel as an electronics assembly engineer. Each module is composed of the components described in Table 1.

Table 1. Module Components and Description

Module Component	Description
Module Pre-Quiz	Short (3 to 5-questions) quiz designed to help you identify what you know and what you still need to learn
Module Sections	"Bite-sized" segments of text, videos, graphics, and activities that explain the key points of the Module content and provide opportunities for you to think about how you would apply electronics assembly processes at work
Module Post-Quiz	Five to 10-question quiz designed to help you confirm what you know, identify areas that still need work.

STUDY TIPS

1. **Use the Learning Objectives**. Refer to the Module learning objectives often.

   Why? Keeping the learning objectives fresh in your mind supports your ability to stay focused on those aspects of the training that will help you achieve the learning goals for the Module.

2. **Quiz yourself.** After you complete a Module, ask yourself questions such as: ***What are the key ideas? What terms or ideas are new to me? How do these ideas relate to what I already know?*** Then, check the Module content to see how well you did.

   Why? Quizzing yourself allows you to identify what you ***really*** know and what you still need to work on.

3. **Quiz yourself periodically.** After you engage with the Module content, quiz yourself and review your answers. Wait a couple of days and quiz yourself again without first reviewing the material.

   Why? Regular self-quizzes help you connect the content to what you already know and what you've thought about since you first learned that content. Tying the content to these other bits of knowledge in your brain makes it easier to recall when you need to apply it on the job later. Research also shows that the effort required to recall what you've learned entrenches it more firmly into your long-term memory than if you were to re-read or highlight the same material.

4. **Mix it up.** When you quiz yourself, mix in topics or questions from different Modules. Online or homemade flashcards can make this fun. Just remember to keep the cards you get right in the rotation even if they appear less often.

   Why? It may be more difficult than practicing one subject at a time, but mixed practice has two distinct advantages. First, because it is more complex and requires more effort, mixed practice more effectively stores the content in your long-term memory. Practicing a lot of the same thing often makes you feel like you've mastered the content, but it's quickly forgotten because you are relying on your short-term memory. Second, in real-life you often have to deal with different types of problems in no particular order. In other words, to be successful, it's better to practice like you play—or work!

5. **Express it in your own words.** Explain the new content to somebody in your own words, or write a summary of each Module, adding images and examples that help you better understand and remember the content.

   Why? Learning, which is ***acquiring knowledge and skills that are easily retrieved from memory so you can address problems and opportunities***, is very much about connecting

new stuff to the older stuff already stored in your memory. Therefore, learning the same topic will be a little different for everybody because each one of us is connecting the new knowledge to different old knowledge. In other words, the most durable kind of learning happens when you connect new content with objects, people, and experiences that are meaningful to ***you***. One of the most effective ways to do that is to express newly learned material in your own words.

6. **Dive in.** Read the Module learning objectives, then try to explain the key ideas. How do these ideas relate to what you already know?

   Why? It may seem silly to try to answer a question or solve a problem before being taught how, but you are much more likely to learn and remember the solution if you try to work your way through it first. In fact, a wide range of experts, from farmers and mechanics to physicists and mathematicians, have sought their answers through a mixture of dogged research and trial and error. Trying to figure something out before you know too much about it puts all your past knowledge to work in search of answers, heightening your awareness of what you do and do not know about the topic at hand. When you hit on those answers, the new knowledge easily and firmly connects to the related concepts and experiences in your memory because you have been actively remembering them.

   Even if you are not right on every count, the effort will have primed your brain to find, learn, remember, and recall the Module content that is new to you.

7. **Take time to think about it.** While doing some routine task like walking the dog, jogging, or washing the dishes, take a few minutes to think about a recent learning experience. ***What are the main ideas and how do they relate to my work? Can I apply what I've learned to improve my job performance?*** If you've already tried to apply what you've learned at work, ask what went well and what went poorly. What do you need to learn or do to get better results the next time?

   Why? Thinking about how your past experiences and current knowhow relate to what you've recently learned helps to connect and store this new knowledge in your long-term memory so that it is easy to recall when needed. Considering how well you learn something or how well you apply that learning at work will help you identify effective learning and workplace strategies. Think about an especially successful learning or work experience. What was different about those experiences? How can you take what worked and apply it to this situation?

8. **Limit your study time.** Work through relatively small amounts of information in 20- or 30-minute sittings rather than long, continuous study sessions.

   Why? Our brains can only process so much information at a time. Learning is more effective when you give your brain a little time to sort and transfer information from

working memory to long-term memory. If you take on too much at a time, or proceed too quickly, you may overload your working memory and forget important parts of the content before they are committed to your long-term memory.

9. **Sleep.** Be sure to get the right amount of sleep. You may be able to function with less, but most healthy adults should get between 7 and 9 hours of sleep each night. Teens and children require more.

   Why? Your brain uses down time to sort through the day's input, dumping the unnecessary bits and integrating newly learned material with what we already know. While you sleep, the rest of your body goes about repairing tissue, generating new cells, and eliminating toxins. Research shows that healthy sleeping habits lead to improved mood, weight loss, increased ability to learn and retain information, and better performance.

10. **Cut out distractions.** Set aside your smartphone, and resist answering emails, surfing the Net for your next purchase, or checking in on your Facebook page.

11. **Focus on one thing at a time.** Effective multitasking is a widespread myth. Research shows that multitaskers had a very difficult time sorting through irrelevant material and were outperformed by more singularly focused people across many different measures.

    Why? Aside from compromising the quality of your work, distractions and multitasking take a big bite out of the limited amount of time you have to get things done. Every time you switch tasks, you waste time getting yourself started on the new task and restarting the one you stopped. Research shows that task switching can eat up to 25% of your time depending on the complexity of the tasks. Twenty-five percent represents 10 hours of a 40-hour work week!

12. **Believe in yourself.** It's important to realize that you can literally increase your brain power and become an expert at whatever you put your mind to. You are not stuck with some finite amount of intellectual ability at birth. In other words, if you think you can or think you can't, you're right.

    Why? Research has proven that the human brain is malleable. It grows new and faster connections through the effort of learning. If you feel that you are "bad" at something like math or gardening, you can become much better with deliberate and persistent study and practice. If you haven't had much success until now, you may have been using poor study strategies. For example, extensive research has shown that multiple re-readings in close succession, highlighting, and continually poring over notes are time-consuming strategies that yield poor results at the cost of the more effective strategies described here. However, it's important that you adjust your mindset to truly take these facts into account. A learning setback is not a result of limited intelligence. It simply means that you

may have to change strategies, increase focus, get creative, or work harder. It's also important to remember that learning things in a permanent and easily retrievable way requires effort.

The authors of ***Make It Stick: The Science of Successful Learning*** describe how the effort you put into the study strategies described above lead to meaningful learning:

> Effortful recall of learning…requires that you "reload" or reconstruct the components of the skill or material anew from long-term memory rather than mindlessly repeating them from memory. During this focused, effortful recall, the learning is made pliable again: the most salient aspects of it become clearer, and the consequent reconsolidation helps to reinforce meaning, strengthen connections to prior knowledge, bolster the cues and retrieval routes for recalling it later, and weaken competing routes.

RESOURCES:

Andreatta, B. (2016). ***Wired to grow: Harness the power of brain science to master any skill.*** Santa Barbara, CA: Seventh Mind Publishing.

Brown, P. C., Roediger, H. L., & McDaniel, M. A. (2014). ***Make it stick: The science of successful learning.*** Cambridge, MA: The Belknap Press of Harvard University Press.

Carey, B. (2015). ***How we learn: The surprising truth about when, where, and why it happens.*** New York, NY: Random House.

Dweck, C. S. (2008). *Mindset: The new psychology of success.* New York, NY: Ballantine Books.

Keller, G. W., & Papasan, J. (2013). ***The one thing: The surprisingly simple truth behind extraordinary results.*** Hudson Bend, TX: Bard Press.

IPC EDGE LEARNING MANAGEMENT SYSTEM

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