# AC 2010-969: DEVELOPING AN INDUSTRY-DRIVEN GRADUATE CERTIFICATE IN TEST ENGINEERING FOR ELECTRICAL ENGINEERING TECHNOLOGISTS

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# Developing an Industry-Driven Graduate Certificate in Test Engineering for Electrical Engineering Technologists


## Abstract

The School of Technology (SofT) plans to be nationally recognized for programs advancing technological education through excellence in learning, discovery, and engagement. To achieve this result, the Electrical Engineering Technology (EET) program as part of the School of Technology needs to continue to improve curriculum that prepare graduates for careers in a wide scope industry and support a broad spectrum of technology. The EET program is collaborating with GE Aviation to offer a graduate certificate in Test Engineering. This certificate represents a good model of collaboration between industry and academia. The demand for electrical and computer engineers who are equipped with test engineering skills continue to rise. Unfortunately, the curriculum has not yet "caught up" to industry needs and the role of academia in meeting industry expectation of test engineering skills has not been sufficient. Only a few universities have test engineering incorporated in their curriculum. To meet this goal, the School of Technology is stepping up to this challenge and is collaborating with local industry, specially GE Aviation, to develop a Test Engineering curriculum. This paper describes the development of a new graduate certificate in Test Engineering in the EET program and in collaboration with industry.


## Introduction

The demand for electrical and computer engineers who are equipped with test engineering skills continues to rise. Electrical and Computer engineering jobs data reflects that 40 to 60% of electrical and computer engineering jobs are in testing. In addition to this, jobs data also shows that most military and government engineering jobs are mainly test engineering jobs[1]. Unfortunately, the curriculum has not yet "caught up" to industry needs and the role of academia in meeting industry expectation of test engineering skills has not been sufficient. Only a few universities have testing engineering incorporated in their curriculum. To meet this need, academic institutions must re-shape their curriculum to offer students the opportunity to learn test engineering skills. Currently, test engineering skills are usually gained through work experience and on-the-job training, but not through formal college education. To effectively meet the next generation's workforce need for test engineers, the EET curriculum must be current, relevant, and teach skills that are widely needed in industry. To meet this goal, the School of Technology is stepping up to this challenge and collaborating with GE aviation to develop a test engineering curriculum. The graduate certificate will represent and build a stronger EET program within the School of Technology. Students earning the Test Engineering graduate certificate will be given the opportunity to learn and experience the theory and practice of fundamental test engineering.

Graduates will represent a pool of informed electrical engineering technologists from which industry can draw their potential staff.

**Motivation**

In a survey conducted on test engineers in industry[2], only 21.6% said they were introduced to test engineering skills as part of their college education. 22.5% learned test engineering skills on-the-job and through interaction with colleagues, and 16% were self-educated and developed test engineering skills through trial and error. Engineering school curriculums lack test engineering content[2]. Absher[1] conducted a curriculum review of the twenty universities known to offer some test engineering content. The results showed little evidence of integrating test engineering topics into the electrical engineering curriculum, instead they mainly focusing on the design aspect of engineering problems with less emphasis on the test and functional verification aspect of the product development process. To our knowledge, there is no formal college education in test engineering at the graduate level, with the exception of Georgia Institute of Technology which is engaged in a collaboration with the Department of Defense. They have developed a Master of Science in Test and Evaluation[1]. The Southern University introduced only one course in Test Engineering in the Electrical Engineering Department. The course covering analog and mixed signal circuits is a collaboration with Texas Instruments[5].

The main motivation for developing the new graduate certificate in test engineering was to respond to the market needs of skilled test engineers with relevant skills in test engineering fundamentals. The EET program curriculum must be up-to-date and relevant. It must effectively teach the rapidly changing test engineering technology that is widely used in industry. The addition of the certificate is a result of consultation with their Industry Advisory Board and in collaboration with GE Aviation. As a result, the School of Technology is stepping up to this challenge by introducing the graduate certificate to give engineering and engineering technology students the opportunity to learn and experience the theory and application of test engineering fundamentals. In addition to broadening the skill set of our School of Technology's graduates, our efforts are interdisciplinary and will generate a high impact on the university as a whole as well as across the industry.

The career opportunities awaiting the electrical engineers/technologists with test engineering skills are excellent. Companies have identified the problem of finding a test engineer who knows every aspect of testing methodology. This was the main driver for GE to approach the School of Technology to develop this graduate certificate. GE and the EET program industrial advisory board were heavily involved in curriculum development for the graduate certificate.

## Learning Outcomes

Test Engineering is the process of verifying that a product performs within specified parameters[4]. Test Engineers should have a mastery of circuit analysis and the ability to design and troubleshoot hardware using laboratory equipment as well as Automatic Test Equipment (ATE). The test engineer should also have knowledge of programming skills such as C++, MATLAB, and LabVIEW to design testing scripts for ATE equipment. Test Engineers should have strong communication skills to effectively communicate technical issues to product designers. The desired outcomes of the test engineering graduate certificate were adopted from ABET's (a) through (k) outcomes[6] shown in Table 1.

**Table 1 Test Engineering Graduate Certificate Learning Outcomes[6]**

| | |
|---|---|
| Outcome 1 | The application of circuit analysis and design, computer programming, associated software, analog and digital electronics, and microcomputers to the building, testing, operation and maintenance of electrical/electronic(s) systems using laboratory equipments an Automatic Test Equipment (ATE). (ABET 8.a) |
| Outcome 2 | An appropriate mastery of the knowledge, techniques, skills and modern tools relevant to test engineering (ABET 2.a ) |
| Outcome 3 | An ability to conduct, analyze and interpret experiments and apply experimental results to improve processes (ABET 2.c) |
| Outcome 4 | An ability to function effectively on teams and communicate effectively (ABET 2.e ) |
| Outcome 5 | A commitment to quality, timeliness and continuous improvement (ABET 2.k) |

## Partnership with Industry

The School of Technology has established a collaboration with GE-Aviation to develop the graduate certificate in Test Engineering. GE expressed an interest in working with the School of Technology and was heavily involved in the curriculum development. Also, GE agreed to offer their facilities for on-site laboratories, this allows students to have access to ATE test equipment and field trips. The industrial advisory board also provided guidance, reviewed the certificate proposal, and made curriculum suggestions.

Our approach to curriculum development is industry-driven. The certificate program is very versatile, and will accommodate the needs of currently enrolled students in both the Electrical Engineering Technology program and the traditional Electrical Engineering program. It is expected that the certificate will be of interest to employees of GE and employees of other companies looking to improve their skills and knowledge in test engineering.

**Certificate Requirement**

The graduate certificate will be delivered in 15 semester credits hours and include three required courses in Electronic Manufacturing, Test Engineering Fundamentals and Quality Control. It will also require two more electives from a set of courses which include: Advanced Data Acquisition, Digital Hardware Testing, Optical System Design and Evaluation, and EMC Test Engineering. More courses will need to be added to the curriculum to create the graduate certificate in Test Engineering. The graduate certificate curriculum will enjoy the addition of five new technical courses to the EET curriculum. The following is a short description of each individual new course.

**Table 2 Required Courses (9 Credits)**

| Course | Title | Credit Hours | Weekly Lecture | Weekly Lab |
|---|---|---|---|---|
| EET 5120 | Electronic Manufacturing | 3 | 3 | 0 |
| EET 5100 | Test Engineering Fundamentals | 3 | 3 | 0 |
| EET 5171 | Quality Control | 3 | 3 | 0 |

In addition to the required courses, a list of new elective courses is also added. Table 3 shows the list of the elective courses. Students will choose up to 6 credit hours from the list of elective courses.

**Table 3 Elective Courses**

| Course | Title | Credit Hours | Weekly Lecture | Weekly Lab |
|---|---|---|---|---|
| EET 4253 | LabVIEW Programming for Data Acquisition | 3 | 2 | 3 |
| EET 5241 | Digital Hardware testing | 3 | 2 | 2 |
| EET 5261 | Optical System Design and Testing | 3 | 2 | 2 |
| EET 5221 | EMC Test Engineering Fundamentals | 3 | 3 | 0 |

**List of Courses**

1. Electronic Manufacturing
   The course emphasizes on the fundamentals of signal transmission theory, digital circuit design, the role of packaging in circuit performance and PCB manufacturing.

2. LabVIEW Programming for Data Acquisition
   This course will focus on graphical programming using LabVIEW. Data acquisition and control programs will be written. Transducer utilization and

signal conditioning are studied, including handling of noise. DAQ interface will be designed, built, and implemented.

3. Test Engineering Fundamentals
   This course is the core introduction to the Test Engineering graduate certificate. As such, this course covers much of the terminology, economics, justification and methods for test which are common to multiple course offerings later in the curriculum This course will cover, among other topics, design for testability (DFT), test economics and product quality, fault models and evidence, functional and statistical techniques for test, IC parametric test, automated testing, Boundary Scan techniques, built-in self test, and board level design for testability.

4. Digital Hardware Testing
   The course emphasizes the fundamentals of digital hardware Design for Testability, faults in digital circuits, fault simulation and test generation, memory testing, testing of sequential circuits, microprocessor testing, des, digital circuit design, the role of packaging in circuit performance and PCB manufacturing.

5. Quality Control
   The course will teach the fundamentals of statistical quality control, with emphasis on process improvement and on reduction of variation. Numerous practical problems will focus on such topics as root cause analysis, measures of quality, costs of quality, systems thinking, as well as on various quality control systems such as ISO/TS 16949 and Six Sigma.

6. Optical System Design and Testing
   The fundamental concepts of optical system design and testing are presented at the moderate level. Simulation tools for modeling a broad range of optical components and systems are designed to enhance the learning process. Laboratory experiments are intended to provide hands-on experience building practical optical systems.

7. EMC Test Engineering Fundamentals
   This course is an introduction to the concepts and methodologies used in Electromagnetic Compatibility conformance testing and will explore common design flaws that result in EMC issues as well as the industry standard test methods used to uncover those flaws. It is intended as preparation for the NARTE EMC Technician and Engineer Exam.

**Conclusion**

The Electrical Engineering Technology program as part of the School of Technology needs to continue improving the curriculum by introducing new curriculum initiatives in respond to industrial needs; this will widen the scope of

the current EET program. The development of the Test Engineering Graduate Certificate will create a significant impact on education in the School of Technology and the University as a whole. The curriculum reform efforts will be informed by extended faculty interactions with industry and will be carefully evaluated by our industrial partners. In addition, the evaluated and revised curricular resources will have a wide impact on Electrical Engineering education. Specially, only few universities have test engineering incorporated in their curriculum. The objectives of this paper were to present the development of a new graduate certificate in Test Engineering in the EET program in collaboration with industry. This partnership creates an important link between academia and industry. It is anticipated that the job outlook for the test engineering graduates will continue to grow. This will make the graduate certificate at the School of Technology a much desired program.

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