

Control Education at KFUPM

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1. Introduction

A major amount of the Saudi national income comes from the oil industry. However, the petrochemical industries contribute significantly in the national income of the country.

Dhahran is one of the major cities in the eastern coast of the Kingdom of Saudi Arabia (KSA). Saudi Aramco, the major oil producing company in Saudi Arabia, has its major headquarters in Dhahran. Not too far from Dhahran is the industrial city of Jubail, the home for the major petrochemical industrial companies in Saudi Arabia. Some other process type industries and discrete events industries are located in a reasonable proximity of Dhahran.

In this part of Saudi Arabia, KFUPM was established in 1963 as the College of Petroleum and Minerals. As the name might imply, few engineering disciplines were established at that time. The institute status was changed to university status in 1975. Now, the university covers almost all engineering, and science disciplines including Architectural, Civil, Computer, Electrical, Mechanical, and Petroleum engineering. In addition, the university has a college of sciences offering programs in Chemistry, Mathematics, and Physics sciences. A college of environmental design and another college for industrial management are also offering undergraduate and graduate programs.

The academic year is divided into two regular semesters of 15 weeks each, with an eight-week summer session. The letter grade and the grade-point average systems are used. An engineering student has to finish a total of 132 credit hours to earn his degree. The requirements are subdivided into four categories: general education, courses in the specific field of study, two to three elective courses, and a period of eight weeks, for the summer training option, or twenty eight weeks for the cooperative program option. However, students enrolled in the summer training option have to take a senior project, which draws upon various

components of the undergraduate program.

2. Control Program

Motivated by the need for control engineers in key industries such as the petrochemical and the oil industries, many institutions in this part of Asia established special control programs in control or even control departments. See Table 1 for some examples.

Table 1. Examples of Control Programs.

Program	University	Country
Automatic Control and Industrial Electronics Engg.	Halab	Syria
Electrical and Control Engg.	Technology	Iraq
Systems Engg.	KFUPM	KSA
Control and Computer Engg.	AL-Mansoorah	Egypt

In the above table, only institutes with special control programs are listed. There are many other institutes which offer control courses such as the universities of Kuwait, Bahrain, Basrah in Iraq, Damascus in Syria and many other universities and institutions. The courses are mainly offered in the departments of electrical, mechanical, chemical, and in few cases in the petroleum and the nuclear engineering department[2].

Classical control courses are taught in the Chemical Engineering, the Mechanical Engineering, the Electrical Engineering, and the Systems Engineering. A first -undergraduate control course is offered as a core course in all of the above departments. In addition, the Electrical Engineering department offers other undergraduate and graduate courses for its students. However, the Systems engineering department has an option in Automatic Control, which focuses on process, control, instrumentation for the undergraduate program.

The department of Systems Engineering offers two options: the Industrial Engineering/Operation Research option, and the Automatic Control/Automation option. A minimum overlap of several courses between the two

options exists.

This overlap was designed intentionally to (1) Broaden the students horizon of thinking and knowledge, (2) To help increase job opportunities per graduate. Most of the control option graduates join the oil refineries, the chemical and desalination, the petrochemical, or the power generation and distribution industries.

The control core courses for the control option are given below [1].

SE207 Modelling and Simulation

SE302 Control Systems

SE311 Digital Logic

SE312 Instrumentation

SE315 Signals and Systems

SE401 Computer Control Systems

SE417 Microprocessors in Automation

SE418 Industrial Process Control

In addition to the above core courses, a student has to take three electives. The elective courses offered by the Systems Engineering department are listed below.

SE434 Introduction to Robust Control

SE435 Control Systems Design

SE438 Instrumentation for Process Control

SE432 Digital Signal Processing

SE436 Stochastic Processes

SExxx Special Topics in Control

In the last year of his study, a student is required to register for either the summer training option, or the cooperative program option. In the cooperative program option, the student will spend a period of one regular semester, and a summer in one of the local industries. In this period, he will be treated like an engineer where he will be given serious assignments to work in and deliver the outcome of his study to the industrial institute he was assign to. At the start of this period, each student is asked to select an advisor from the department to work with him in the throughout his Cooperative period. After finishing this assignment period, the student has to write his findings in a report, and present it to the systems engineering department. In the summer training option, the student will join one of the local industries for eight weeks to have an exposure to what the real work look like. He then writes a report about his summer training period and presents it to the department. A student in this option will have to work in a senior project. To fulfil the requirements for the senior project, the student has to deliver an original work. This work could be software development, hardware development, control schemes implementation on actual process, and in very few cases come theoretical work. Samples of some of the work

done by the systems engineering department are given in the next section.

3. Laboratory

The aim of a control system program is to integrate control theory and applications and to present the integrated material at levels consistent with the need of the students. Our control program covers frequency analysis methods, state feedback methods, modelling and identification. The feedback we are getting from the industry hints to the need for more hands on experiments[3]. To elevate the high level of abstraction faced by the students in the control courses option, laboratory sessions need to be designed and planned carefully.

In our laboratories we have The following equipment. The analogue computer is used for our SE 207 course. The two tank apparatus, the DC motor, transfer functions modules, and MATLAB are used for SE302. The two tank system, the ball and beam, the analogue to digital and digital to analogue converters trainers, the traffic light module, and programmable logic controllers are used for SE 401, different sensors and signal conditioning circuits are used for SE 312. In addition, many other equipment are used for other undergraduate and graduate courses and for senior projects.

4. A Sample of Senior Projects Work

Graduating students each year carried out several senior projects. Below is a sample of recent projects.

In one project, the student was responsible for the design and to put together a circuit and supporting software to perform the on-line generation of frequency plots. The device could be used to measure the frequency and the amplitude of a given signal and the phase between two signals. The measurements can then be used to generate the Bode, and the Nyquist plots.

In another project, the student was asked to design a mini network for control purposes. The network consists of three personal computers, and two processes. One of the processes is the two-tank system and the other is the traffic light system. The hardware circuit and the supporting software were developed.

An automatic blending process was designed, fabricated and some control schemes were implemented and tested on the two input two output process.

5. Graduate Program

Both the systems engineering and the electrical engineering departments offer graduate degrees. They offer M.S. and Ph.D. degrees with emphasis in control. Students with GPA of at least 2.5/4 and 3.2/4 can apply for admission in the M.S. and the Ph.D. programs respectively. A total of 24 credit hours are required for the M.S. program, and a total of 30 credit hours for the Ph.D. students. Twenty-one hours are to be taken in the control area and the remaining nine hours are to be taken in the student's minor. A master thesis is a must for the M.S. program, and a Ph.D. dissertation is also required. For Ph.D. students, an entrance examination is administrated during the first or second semester of their enrolment. After completing the required courses, the Ph.D. student will take his comprehensive examination. Upon passing this examination, the student will submit his research proposal, which is evaluated by student's Ph.D. committee. After the students are done with his research work, a public defence is scheduled. The degree is awarded after a successful defence.

Graduate courses cover all aspects and areas of control. Typical course offering includes

- Linear Control Theory
- Optimal Control
- Non-linear Control
- Adaptive Systems
- Identification

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- Distributed Computer Control
- Robust Control
- Estimation and Detection
- H-infinity Control
- Large Scale Systems

6. Conclusions

An overview of control education at KFUPM is presented. Undergraduate and graduate programs were presented. The laboratory activities were also reviewed.

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References

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