# BASIC ANALYSIS METHODS FOR PARTICLE DETECTORS

| | | | |
|---|---|---|---|
| 1 | Course Title: | BASIC ANALYSIS METHODS FOR PARTICLE DETECTORS | |
| 2 | Course Code: | FZK5621 | |
| 3 | Type of Course: | Optional | |
| 4 | Level of Course: | Second Cycle | |
| 5 | Year of Study: | 1 | |
| 6 | Semester: | 1 | |
| 7 | ECTS Credits Allocated: | 6.00 | |
| 8 | Theoretical (hour/week): | 3.00 | |
| 9 | Practice (hour/week): | 0.00 | |
| 10 | Laboratory (hour/week): | 0 | |
| 11 | Prerequisites: | | |
| 12 | Language: | Turkish | |
| 13 | Mode of Delivery: | Face to face | |
| 14 | Course Coordinator: | Prof. Dr. ÖZKAN ŞAHİN | |
| 15 | Course Lecturers: | | |
| 16 | Contact information of the Course Coordinator: | Doç. Dr. Özkan ŞAHİN,<br>email: osahin@uludag.edu.tr,<br>Telf: 224 2941706,<br>BUÜ Fen Edebiyat Fakültesi, Fizik Bölümü, 16059, Görükle Kampusü, Bursa | |
| 17 | Website: | | |
| 18 | Objective of the Course: | To learn the coding languages and software tools commonly used in the simulation of particle detectors at a basic level, and to acquire the ability to analyze experimental data. | |
| 19 | Contribution of the Course to Professional Development: | By learning the calculations of physical events in particle detectors, the student develops the ability to solve basic problems in detectors. | |
| 20 | Learning Outcomes: | | |
| | | 1 | Learns the calculation methods of Fortran and C ++ programming languages in Unix based operating systems. |
| | | 2 | Learns how to install and operate a large number of software tools widely used in the simulation of particles such as Magboltz and Garfield ++ in gas mixtures, and use basic examples. |
| | | 3 | Learn how to calculate the physical parameters of electrons such as drift and diffusion rates, ionization and excitation frequencies. |
| | | 4 | Have basic knowledge about the software tools that can calculate the electrical field based on a finite element method for different detector geometries. |
| | | 5 | |
| | | 6 | |
| | | 7 | |
| | | 8 | |
| | | 9 | |
| | | 10 | |
| 21 | Course Content: | | |
| | **Course Content:** | | |
| Week | Theoretical | | Practice |

| | | |
|---|---|---|
| **1** | Basic concepts for the Fortran programming language | |
| **2** | Basic concepts for the C++ programming language | |
| **3** | The Linux operating system and simple commands | |
| **4** | General introduction of tools widely used for simulation of gaseous particle detectors | |
| **5** | Installation of Magboltz software and learning its features | |
| **6** | Preparation of Magboltz input files and comprehension of its output files | |
| **7** | Calculating the drift velocity of electrons in gas mixtures using Magboltz | |
| **8** | Calculation of Townsend ionization coefficients using Magboltz | |
| **9** | Calculating the frequencies of excitation levels with Magboltz | |
| **10** | Installing the ROOT analysis program and running with simple examples | |
| **11** | ntroduction to fits with ROOT analysis program | |
| **12** | Installing the Garfield ++ program and running with simple examples | |
| **13** | Features of Garfield ++ and GEANT4 interface program | |

| Activites | | Number | Duration (hour) | Total Work Load (hour) |
|---|---|---|---|---|
| Theoretical | | 14 | 3.00 | 42.00 |
| Practicals/Labs | | 0 | 0.00 | 0.00 |
| Self study and preperation | | 14 | 5.00 | 70.00 |
| Homeworks | | 14 | 3.00 | 42.00 |
| Projects | | 0 | 0.00 | 0.00 |
| Field Studies | | 0 | 0.00 | 0.00 |
| Midterm exams | | 0 | 0.00 | 0.00 |
| Others | | 14 | 2.00 | 28.00 |
| Final Exams | | 1 | 2.00 | 2.00 |
| Total Work Load | | | | 184.00 |
| Total work load/ 30 hr | | | | 6.13 |
| ECTS Credit of the Course | | | | 6.00 |

| | | |
|---|---|---|
| **22** | Textbooks, References and/or Other Materials: | 1.Can Aktaş (2016), "Fortran 90 ile Programlama", PARADİGMA AKADEMİ YAYINLARI<br>2. Ali Başım Yayım, İstanbul.<br>3. Yalçın Özkan (2009), "C++ ile Programlama, Nesneye<br>4. MAGBOLTZ - transport of electrons in gas mixtures, https://magboltz.web.cern.ch/magboltz/<br>5. High energy physics and other, https://root.cern.ch/<br>6. GARFIELD++: a toolkit for the detailed simulation of<br>https://garfieldpp.web.cern.ch/garfieldpp/<br>https://garfieldpp.web.cern.ch/garfieldpp/examples/geant4-<br>9. ELMER: an open source multiphysical simulation software, https://www.csc.fi/web/elmer<br>10. nBEM: A nearly exact Boundary Element Method, http://nebem.web.cern.ch/nebem/<br>11. WG4 Modelling of Physics Processes and Software Tools, https://twiki.cern.ch/twiki/bin/view/MPGD/WG4-Simulation |
| **23** | Assesment | |

| TERM LEARNING ACTIVITIES | NUMBER | WEIGHT |
|---|---|---|
| Midterm Exam | 0 | 0.00 |
| Quiz | 0 | 0.00 |
| Home work-project | 2 | 40.00 |

| | | |
|---|---|---|
| Final Exam | 1 | 60.00 |
| Total | 3 | 100.00 |
| Contribution of Term (Year) Learning Activities to Success Grade | | 40.00 |
| Contribution of Final Exam to Success Grade | | 60.00 |
| Total | | 100.00 |
| Measurement and Evaluation Techniques Used in the Course | | Written Examination |

## 24 ECTS / WORK LOAD TABLE

## 25 CONTRIBUTION OF LEARNING OUTCOMES TO PROGRAMME QUALIFICATIONS

| | PQ1 | PQ2 | PQ3 | PQ4 | PQ5 | PQ6 | PQ7 | PQ8 | PQ9 | PQ10 | PQ11 | PQ12 | PQ13 | PQ14 | PQ15 | PQ16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ÖK1** | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 |
| **ÖK2** | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **ÖK3** | 4 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |
| **ÖK4** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 |

**LO: Learning Objectives PQ: Program Qualifications**

| | | | | | |
|---|---|---|---|---|---|
| **Contribution Level:** | **1 very low** | **2 low** | **3 Medium** | **4 High** | **5 Very High** |