THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Physics Engineering III & IV – Engineering Unit
Computer Programming Module
Academic Year 2020-2021

Physics Engineering Strand – Governor's School for Science and Technology

Teacher Name: Ibrahim H. Albayrak, Dr.
Office: A71
School Phone #: 757-766-1100
Teacher Extension: x3393
Class Fees: None

Course Title: Physics Engineering III & IV

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School Fax #: 757-224-5420
Office Hours: After school and by appt.

I. Introduction

1. **Course Description:** Introduces computers, their architecture and software. Teaches program development using flowcharts. Introduces problem solving techniques involving programming in C++ language.
2. **Course Credits:** 3 credits. Total 4 hours per week, lecture 2 hours, lab 2 hours.
3. **Prerequisites/Co-requisites**
    - Engineering Physics I, II
4. **Required Materials**
    - Notebook (3-ring binder preferred)
    - Engineering notebook
    - Pencil(s), erasers, graduated straight edge
    - Scientific Calculator (e.g. TI-30, Casio fx-300, or better)

II. Course Content

1. Introduction to computers and programming
    a. Basic digital computer architecture
    b. Computer organization and operating systems
    c. Code, programming, and levels of programming languages
2. Introduction to programming in C++ - An introduction to the popular programming language embedded in many engineering systems and processes

    a. Programming basics: the flow of information, programming inputs and outputs, and data operations
    b. Introduction to C++: Object-Oriented Programming, classes, objects, member functions, and data members
    c. Programming strategy and design
        i. Flowcharting
        ii. Input and output of numeric, character, and string data
    d. Program flow and control:
        i. Relational and logical operators
        ii. If, ese, else/if statements
        iii. Looping structures
    e. Functions, function types
        i. Argument passing by value and by referencing
        ii. Local versus global variables
        iii. Overloaded functions
    f. Vectors, arrays
        i. Declaring, creating, and initializing arrays
        ii. Common array manipulations
    g. Pointers, pointer-based operations
        i. Concept and use of the pointer
        ii. Pointer expressions and arithmetic
        iii. Pointer-based strings
    h. Characters, C-Strings, and class `string` functions
    i. Structured data
    j. Introduction to Classes

III. Instructional Methods

Course Text: ISBN-13: 978-0133378719 Deitel and Deitel, C++ How to Program (9th Edition); Pearson; Upper Saddle River NJ; 2013. Multiple downloads from Internet sources.

The course focuses on the computer as engineering design and problem-solving tool, encompassing modern graphical and computational aspects of the engineering profession. Students demonstrate skills in structuring engineering problems for solution on the computer and create algorithms, design programs, and execute them using C++.

IV. Student Learning Outcomes

1. Apply software development methods to translate an engineering problem solution into an algorithm.
2. Translate algorithm steps into C++ language statements.
3. Write a C++ program that will interact with a user: accept input, perform a mathematical calculation, and display the result.
4. Develop modular programs using functions that accept zero or multiple inputs and return none or one value.
5. Apply engineering design method and top-down programming practices to obtain solutions to engineering problems in a collaborative environment.

V. Evaluation and Assessment

Grading: Each course consists of classwork, homework, exams and quizzes, and projects. Student work will be evaluated using the following weighted components and grade scale.

a. 30% Attendance, Research reports and presentations
b. 30% Quizzes, Problem sessions and homework
c. 40% Exams, projects

Course Grade Scale

Final course grades will be assigned using the following scale as a guide:

90-100 A
80-89 B
70-79 C
60-69 D
0-59 F

THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Engineering Physics III & IV – Engineering Unit
Introduction to Engineering Graphics Module
Academic Year 2020-21

Engineering Physics Strand – Governor's School for Science and Technology

Teacher Name: Ibrahim H. Albayrak, PhD
Office: A71
School Phone #: 757-766-1100
Teacher Extension: x3393
Class Fees: none

Course Title: Engineering Physics III & IV

Email: ibrahim.albayrak@nhrec.org
School Fax #: 757-224-5420
Office Hours: After school and by appt.

I. Introduction

1. **Course Description:** Presents theories and principles of orthographic projection. Studies multiview, pictorial drawings and sketches, geometric construction, sectioning, lettering, tolerancing, dimensioning and auxiliary projections. Studies the analysis and graphic presentation of space relationships of fundamental geometric elements: points, lines, lanes, and solids. Includes instruction in Computer Aided Drafting.
2. **Course Credits:** 3 credit hours. Total 1-5 hours per week, 0-2 hours lecture with 0-3 hours lab.
3. **Prerequisites/Co-requisites**
    - Engineering Physics I, II
4. **Required Materials**
    - Notebook (3-ring binder preferred)
    - Engineering notebook
    - Pencil(s), erasers, graduated straight edge
    - Scientific Calculator (e.g. TI-30, Casio fx-300, or better)

II. Course Content

1. Introduction to CAD
    a. The importance of the sketch as engineering communication
    b. History of engineering drawing
    c. Modern design, modeling, analysis, and fabrication workflow environment
2. Introduction to CADKEY (aka, KEYCREATOR) software environment
    a. Introduction to the user interface
    b. Loading and saving files
    c. Creating templates
    d. Creating entities, assigning attributes, adding text and detailing
3. Using basic CAD object drawing methods
    a. Lines, planes, circles, arcs, angles, fillets and rounds
    b. Standard views, auxiliary views, tolerancing, dimensioning standards
4. Working in a Team Environment
    a. Benefits and challenges of working on a design team
    b. Planning, organizing, and leading team resources, tasks, and schedule
    c. Measuring, analyzing, and improving team performance
    d. Understanding team dynamics and overcoming team member disputes and differences
5. The Design Process
    a. Steps in the typical engineering design or problem solving process (The McMaster 5-Point Strategy)
    b. Clarifying and defining design objectives, metrics, and constraints
    c. Understanding, communicating, and meeting the client or customer's needs
6. Other Sketching and Modeling Techniques
    a. Creating features on alternate planes
    b. Work features such work planes, work axes, and work points
7. Other Advanced CAD Techniques
    a. Mirror commands, rotation commands, render views, revolving, creating blocks, cylinders, and cutting
    b. Advanced editing, deconstruction and reconstruction, feature suppression
    c. Implementing auto-dimensioning
8. Assembly Modeling
    a. Assembly modeling concepts
    b. Creating and manipulating individual assembly components
9. Creating files for fabrication systems
    a. Standard CAD file formats used in modern workflow systems
    b. Generating the STL file
10. Using CAD drawing finishing techniques
    a. Detailing materials, surface textures, specified screen images
    b. Generating basic and custom drawing layouts

11. Prototyping: Using CAD in Pre-fabrication Engineering Analysis
    a. Analysis of the performance or behavior of a system modeled in CAD and using COMSOL multi-physics software.
12. Team Project - The Design Process: From Idea to Fabricated Part
    a. Apply the Engineering Problem Solving process learned in concurrent and previous coursework to conceive, design, and create, using additive manufacturing techniques, an object that meets a client's needs

III. Instructional Methods

Course Texts: ISBN-13: 978-0133091663 Fogler, LeBlanc, and Rizzo, Strategies for Creative Problem Solving, (3rd Edition); Prentice Hall, NY; 2013. ISBN-13: 978-0-13-276671-5 Stephan, Bowman, Park, Sill and Ohland, Thinking Like an Engineer (2nd Edition); Pearson; Upper Saddle River NJ; 2013. ISBN: 978-1-2851-7295-8, Lieu and Sorby Visualization, Modeling, and Graphics for Engineering Design, 2nd Edition, Cengage Learning, Boston, MA.

Engineering graphics is one of the fundamental communications media of the engineering profession. This Engineering Course is a comprehensive course covering many aspects of standard engineering drawing and object representation and accomplished in modern industrial standard computer software. Material is presented in lecture and demonstrated drawing development. Emphasis is placed on drawing presentation for engineering design, fabrication, and analysis, as befits the future careers of the students. Students are encouraged to work in groups on assignments to accelerate learning. A design project leading to the fabrication of an original engineering design using additive manufacture technology capstones the course.

IV. Student Learning Outcomes

1. Visualize and illustrate using sample parts and assemblies.
2. Demonstrate the ability to think critically and orderly to solve graphical problems.
3. Create computer-generated solid models using CAD software.
4. Create assembly models, drawings, and parts lists from CAD parts.
5. Use standard tolerance and dimensioning practices to accurately describe parts and assemblies in orthographic projections
6. Select the appropriate method for illustrating a given part (i.e., sectional views, auxiliary views, pictorial views, etc.)
7. Demonstrate specific skills, understandings, and professional attitudes needed by engineers.
8. Develop a design problem into a solid model with the necessary views to illustrate the project.

V. Evaluation and Assessment

Grading: Each course consists of classwork, homework, exams and quizzes, and projects. Student work will be evaluated using the following weighted components and grade scale.

a. 30% Sketches and CAD assignments
b. 30% Design Project
c. 20% Quizzes
d. 20% Final Exam

Course Grade Scale

Final course grades will be assigned using the following scale as a guide:

90-100 A
80-89 B
70-79 C
60-69 D
0-59 F

THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Physics Engineering III & IV – Engineering Unit
Digital Electronics Module
Academic Year 2020-2021

Physics Engineering Strand – Governor's School for Science and Technology

Teacher Name: Ibrahim H. Albayrak, Dr.
Office: A71
School Phone #: 757-766-1100
Teacher Extension: x3393
Class Fees: None

Course Title: Physics Engineering III & IV

Email: ibrahim.albayrak@nhrec.org
School Fax #: 757-224-5420
Office Hours: After school and by appt.

I. Introduction

1. **Course Description:** Introduces binary number system, logic gates, Karnaugh diagrams and digital electronic systems based on these. Teaches how to construct real life digital electronic devices from basic principles.
2. **Course Credits:** 3 credits. Total 4 hours per week, lecture 2 hours, lab 2 hours.
3. **Prerequisites/Co-requisites**
   - Engineering Physics I, II
4. **Required Materials**

   - Notebook (3-ring binder preferred)
   - Engineering notebook
   - Pencil(s), erasers, graduated straight edge
   - Scientific Calculator (e.g. TI-30, Casio fx-300, or better)

II. Course Content

1. Introduction to binary number system
    a. Number systems
    b. Conversion between binary and decimal number systems
    c. Demonstration of binary system with real electronic devices
2. Introduction to logic gates and Boolean algebra
    a. Introduction to AND, OR, and NOT gates.
    b. Demonstration of logic gates by real digital electronic devices
    c. Performing algebraic operations using basic logic gates
3. Introduction to Karnaugh diagrams. Learn two methods for simplifying logic circuits using boolean equations and Karnaugh maps and then implement the circuits to verify the math.
4. Introduction to design and implementation of lathes, flip flops.
5. Introduction to clocks and oscillators
6. Design and construction of 4 bit shift registers, counters and LED chaser projects
7. Introduction to digital electronic integrated circuits (ICs) such as 7400 and 4000 series.
    a. Design and construction of digital systems using digital ICs.
8. Introduction to digital-analog and analog-digital converters.
    a. Basic principles of DAC and ADC systems
    b. Implementation of DAC and ADC circuits in real life problems
9. Introduction to microcontrollers
    a. Introduction to hardware and software
    b. Introduction to General purpose input and output (GPIO)
    c. Introduction to timing with microcontrollers
    d. Introduction to AD and DA conversion using microcontrollers
    e. Introduction to interrupts and polling features
    f. Communication with microcontrollers
    g. Design and implementation of real life projects with microcontrollers
        i. Sensor projects
        ii. Display output projects

III. Instructional Methods

Course Text: http://www.pyroelectro.com/edu/

The course focuses on digital electronic systems and applications in real life situations. Students demonstrate skills in designing and constructing digital electronic systems using 7400 and 4000 series ICs, ADCs and DACs and microcontrollers.

IV. Student Learning Outcomes

1. Perform algebraic operations in binary number system.
2. Perform more complex algebraic operations using basic logic gates.
3. Construct the real life digital electronic systems that performs algebraic operations.
4. Use DACs and ADCs to measure and record analog signals.
5. Design and construct microcontroller based systems that perform a variety of operations.

V. Evaluation and Assessment

Grading: Each course consists of classwork, homework, exams and quizzes, and projects. Student work will be evaluated using the following weighted components and grade scale.

40% Design Project
30% Quizzes
30% Final Exam

Course Grade Scale

Final course grades will be assigned using the following scale as a guide:

90-100 A
80-89 B
70-79 C
60-69 D
0-59 F

THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

Physics & Engineering III & IV EDIE Lab Class

Teacher Name: Ibrahim H. Albayrak, Dr.
Office: A75
School Phone #: 757-766-1100
Teacher Extension: x3393
Class Fees: none

Course Title: Physics and Engineering III & IV EDIE lab Class
Email: ibrahim.albayrak@nhrec.org
School Fax #: 757-224-5420
Office Hours: After school and by appt.

2. **Course Description:**

3. **Course Texts:**

4. **Prerequisites/Co-requisites**
   - Engineering Physics I, II

5. **Required Materials**
   - Notebook (3-ring binder preferred)
   - Pencil(s), erasers, graduated straight edge
   - Scientific Calculator (e.g. TI-30, Casio fx-300, or better)

6. **Academic Integrity:** Any cheating on any exams or quizzes will result in a grade of "0" for that test. Cheating is defined as either the giving or the receiving of unauthorized help. Any indication of cheating will result in a grade of zero for the exam; **a second violation and there will be conferencing with the director**.

7. **Grading:** Each course consists of classwork, homework, exams and quizzes, and projects. Student work will be evaluated using the following weighted components and grade scale. All assessments will be timed to correspond to nationally normed standardized testing.

8. **Evaluation**

   Weighted Components

   a. 20% Research reports and presentations

b. 30% Problem sessions and homework
c. 50% Exams and quizzes

Course Grade Scale

Final course grades will be assigned using the following scale as a guide:

90-100 A
80-89 B
70-79 C
60-69 D
0-59 F

9. Course Outline

1. **EDIE Lab:**
   a. Introduction to engineering process
      i. Importance of Engineering process
      ii. Introducing Research topics
         1. Energy
         2. Space
         3. Education
         4. Health
         5. Entertainment
         6. transportation
      iii. Engineering Design process
   b. Sample projects
      i. Solar energy
      ii. Gyroscope
      iii. clock
   c. Fundamental physics (lecture 1-2 session)
      i. Mechanics and electricity
   d. Keystone Projects

10. Laboratory activities include:
   a. EDIE LAB

11. Times and topics are subject to change. Updated schedules will be announced.