BỘ GIÁO DỤC VÀ ĐÀO TẠO

TRƯỜNG ĐẠI HỌC BÁCH KHOA HÀ NỘI

ĐỀ CƯƠNG CHI TIẾT CÁC HỌC PHẦN

COURSE SYLLABI

CHƯƠNG TRÌNH TIÊN TIẾN GIÁO DỤC ĐẠI HỌC

UNDERGRADUATE ADVANCED PROGRAM

NGÀNH KỸ THUẬT Y SINH

Biomedical Engineering

XÂY DỰNG TỪ CHƯƠNG TRÌNH CỦA TRƯỜNG ĐẠI HỌC

BASED ON THE CURRICULUM OF THE

University of Wisconsin – Madison, Wisconsin USA

HÀ NỘI - 2008

MỤC LỤC

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MI1016 Calculus I

1. Course Title: **Calculus I**

2. Course ID: PI1016

3. Course Units: **4(3-2-0-8)**

- Lecture: 45 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: First-year students in Undergraduate Advanced Programs or other first-year students having good English skills.

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

This is the first course in calculus and analytic geometry. It covers basic notions of functions given in Cartesian coordinate system as well as in Polar coordinate system including techniques of curve sketching, basic techniques of differentiation and integration with variety applications, and partial derivatives and applications in the domain of functions of several variables.

8. Description

Limits and continuity. The derivative and applications to related rates, maxma and minima, and curve sketching. Transcendental functions. An introduction to the definite integral and area.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab work:
- ...

10. Assessment

- Mid-term grade: 0.4 (40%)
  - Home exercise grading
  - Project
  - Lab work and reports
  - Mid-tem test
- Final exam: 0.6 (60%)

11. Course Materials

- Textbook: James Stewart, Calculus, fourth edition, Brooks/Cole Publishing Company

12. Course Topics

Calculus I

Course Developer: Prof. Dr. Nguyen Van Ho

Chapter 1: Functions. Essential function

1. Notions and definitions
   - Function, mapping, domain, independent and dependent variables
   - Four possible ways to represent a function
   - Piecewise defined functions.
   - Symmetry. Odd and even functions.
   - Increasing and decreasing functions
2. Mathematical Models
   - Linear functions.
   - Polynomials.
   - Power functions.
   - Increasing and decreasing functions.
   - Rational functions.
   - Algebraic functions.
   - Trigonometric functions
   - Exponential functions
   - Logarithmic functions
3. New functions from old functions
   - Transformations of functions: translation, stretching and compressing, reflecting, taking the absolute value of a function.
   - Combinations of functions. Operations on functions

Chapter 2: Limits

1. Limit of number sequences
   - Number Sequences
   - Limit of number sequences
   - Limit Laws.
   - Particular limits
2. Limit of functions
   - Definitions. Left-hand and right-hand limits. Theorem.
   - Limit laws
   - Limit of elementary functions
   - Limit of piecewise defined functions.
   - Particular limits
   - Eliminate undefined forms.
3. Infinites and infinitesimals.
   - Theorems.
   - Applications in eliminating the undefined forms.

Chapter 3: Continuity of functions

1. Definitions. Continuity from the left and from the right
2. Properties
3. Theorems.
4. The continuity of elementary functions
5. The continuity of composed functions
6. The intermediate value theorem

Chapter 4: Derivatives

1. Problems: tangents, velocities.
2. Derivatives: definitions, properties.
3. Differentiation rules.
4. Table of elementary derivatives
5. Derivatives of implicit functions
6. Higher order derivatives

Chapter 5: Applications of Derivatives and Differentials

1. Related rates.
2. Linear approximations.
3. Differentials.
4. Higher order differentials.
5. The n-th degree Taylor and Mc Laurin Polynomials.
6. The mean value theorems.
7. The local and global maximum and minimum values.
8. How the derivatives affect the shape of a graph?

Chapter 6: Indefinite Integrals

1. Antiderivatives. Definition. Rules.
2. Indefinite integrals. Definition. Theorem. properties.
3. Table of basic indefinite integrals.
4. The substitute Rule.
5. The integration by parts.
6. Integration of trigonometric functions.
7. Integration of rational functions by partial fractions.
8. Integration of irrational functions:
   rationalizing substitutions, trigonometric substitutions

Chapter 7: Definite Integrals

1. Problems: Area, distance traveled.
2. Definite integrals: Definition. Rules. Theorem.
3. The fundamental Theorem of calculus (part 1): derivative with respect to above bound'.
4. The fundamental Theorem of calculus (part 2): Newton-Leibniz Theorem.
5. The substitute Rule and The integration by parts.
6. Applications:

Area under the curves. Area between the curves.
Volume of solids. Volume of solids of revolution.
Works.
Arc lengths.
Surface areas.

7. Curves defined by parametric equations and by polar coordinates equation: area.
8. Improper Integrals type 1 and type 2:
   Convergence. Divergence. Comparison Theorems.
9. Approximate Integrations:
   Midpoint, trapezoidal and Simpson Rules.
   Error bounds

Chapter 8: Functions of Several Variables

1. Definitions.
2. Limits and continuity.
3. Partial derivatives. Rule for finding the partial derivatives.
4. Higher partial derivatives. Theorem.
5. Tangent planes and approximations.
6. Differentials: Differentiability condition.
7. Higher differentials.
8. The chain rules'
9. The invariant of the first-order differential.
10. Directional Derivatives. Gradient vector.
11. Maximum and minimum values.
12. Method of Lagrange multipliers.

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MI1026 Calculus II

1. Course Title: **Calculus II**

2. Course ID: MI1026

3. Course Units: **4(3-2-0-8)**

- Lecture: 45 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: First-year or second-year students in Undergraduate Advanced Programs or other students having good English skills.

6. Requisites

- Prerequisites: MI1016

7. Objectives and Expected Outcomes

This is the second course in calculus. It covers basic notions of multiple integrals: double integrals, double integrals in polar coordinates, triple integrals, triple integrals in cylindrical and spherical coordinates, line integrals, surface integrals, with variety applications in vector field studies, in mechanics, in electrics, in physics, ...

8. Description

The definite integral and applications to area, volume, work, differential equations, etc. Sequences and series, vectors and analytic geometry in 2 and 3-space, polar coordinates, and parametric equations.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab work:
- ...

10. Assessment

- Mid-term grade: 0.4 (40%)
  - Home exercise grading
  - Project
  - Lab work and reports
  - Mid-tem test
- Final exam: 0.6 (60%)

11. Course Materials

- Textbook: James Stewart, Calculus, fourth edition, Brooks/Cole Publishing Company

12. Course Topics

Calculus II

Course Developer: Prof. Dr. Nguyen Van Ho

Chapter 1: Vectors and the Geometry of Space

7. Vectors
   - Definitions and properties
   - The dot product
   - The cross product.
2. Equations of lines and planes.
   - Equations of lines.
   - Equations of planes.
3. Cylinder and quadric surfaces
   - Cylinder
   - Quadric surfaces
4. Cylindrical and spherical coordinates
   - Cylindrical coordinates
   - Spherical coordinates

Chapter 2: Vector Functions

1. Vector functions
2. Space curves
3. Derivatives and Integrals of vector functions
   - Derivatives.
   - Integrals
4. Arc Length and Curvature.
   - Arc Length.
   - Curvature.
   - The normal and binormal vectors.
5. Motion in space.
   - Velocity.
   - Acceleration
   - Curvature

Chapter 3: Double Integrals

1. Definitions and properties.
2. Volumes and double integrals.
3. The Midpoint Rule for double integrals.
4. Iterated Integrals.
5. Double Integrals in polar coordinates.
6. Applications of double integrals: area, volume, moments and centers of mass, moment of inertia, surface area.
7. Change of variables in double integrals

Chapter 4: Triple Integrals

1. Definitions and properties.
2. Applications of triple integrals: volume, mass, moments and centers of mass, moment of inertia.
3. Triple integrals in cylindrical and spherical coordinates.
4. Change of variables in triple integrals.

Chapter 5: Line Integrals

1. Vector fields.
2. Line integrals.
   - Line integrals in plane.
   - Line integrals in space.
3. Line integrals of vector fields.
4. The Fundamental Theorem for line integrals .
5. Independent of path.
6. Green's theorem.
7. Curl and Divergence.
   - Curl.
   - Divergence.
   - Vector form of Green' theorem.

Chapter 6: Surface Integrals

1. Surface integrals.
2. Oriented surfaces.
3. Applications of Surface Integrals.
   - Surface area.
   - Surface mass.
3. Surface integrals of vector fields.
4. Stock' theorem.
5. The divergence theorem.

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MI1036 Algebra

1. Course Title: **Algebra**

2. Course ID: MI1036

3. Course Units: 4**(3-2-0-6)**

- Lecture: 45 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Second-year students in Undergraduate Advanced Programs or other students having good English skills.

6. Requisites

- Prerequisites:

7. Objectives and Expected Outcomes

This course introduce engineering students to those areas of linear algebra which, from a modern point of view, are most important in connection with practical problems. Students will be introduced to the theory and applications of matrices and linear systems of equations, linear transformations and eigenvalue problems, as they arise, for instance, from electrical networks, frameworks in mechanics, processes in statistics, systems of differential equations and so on. Students will become familiar with ways to think mathematically and recognize the need for applying mathematical methods to engineering problems.

8. Description

Logic; Sets, mapping and complex numbers. Matrix, linear system of equations. Vector spaces, rank and inverse of matrices. Linear mapping and transformation. Eigenvalues and eigenvectors. Euclidean space, orthogonality.

9. Student Duties

- Class attendance is required: 3+2=5 hours/week
- Homework is assigned at each lecture hour
- Quizzes will be given 3 times per semester; Problems in Quizzes are taken from (or similar to) homeworks
- Midterm Exams: There will be two midterm exams per semester
- Final Exam: Problems in the final exam cover the main topics taught during the semester and require through review of all the material covered in the class....

10. Assessment

- Quizzes: 0.2 (20%)
- Mid-term exam: 0.3 (30%)
- Final exam: 0.5 (50%)

11. Course Materials

- Textbook:

12. Course Topics

Algebra

Course Developer: Dr. Nguyen Thieu Huy

I. Logic: (4+2)

1. Symbolic logic, statement and truth label.
2. Compound statements and logical connectives: Negation, conjunction, disjunctions, conditional, biconditional, equivalent expression
3. Tautologies (logical theorem)

II. Sets, mapping and complex numbers: (6+4)

1. Sets and set operations: Notations, subset, intersection, union, complement, Cartesian product,
2. Mapping: definition, properties: injective, surjective, bijective, image, inverse image, composition of mappings, inverse of a bijective mapping.
3. Binary operations; concepts and examples of groups, rings, fields.
4. Field of complex numbers, calculating with complex number: addition, multiplication, trigonometric form, roots, power.

III. Matrix, linear system of equations: (7+5)

1. Basic concepts of matrices: definitions and character.
2. Matrix operations: addition, scalar multiplication, matrix multiplication, transposition.
3. Linear system of equations, Gauss elimination, application to electrical networks.

IV. Vector spaces, rank and inverse of matrices: (8+6)

1. Definition and examples of vector spaces, subspace.
2. Linear independence, Basis, coordinate, dimension, change of basis.
3. Rank of vector system, rank of matrices.
4. Linear system of equations revisited: general properties of solution.
5. Inverse of a matrix, determinant, rank in terms of determinants, Cramer's rule

V. Linear mapping and transformation: (5+3)

1. Linear mapping: definitions, examples, matrix of a linear mapping; kernel, range and rank of linear mapping.
2. Isomorphous spaces
3. Linear transformation: matrix of a linear transformation, change of basis. Similarity

VI. Eigenvalues and eigenvectors: (7+5)

1. Eigenvalues and eigenvectors of a matrix and of linear transformations
2. Some applications of eigenvalue problems: stretching of an elastic membrane, Markov process, population models.
3. Properties of eigenvectors, characteristic equations, diagonolization of a matrix.

VII. Euclidean space, orthogonality: (8+5)

1. Inner products, length and orthogonality, Euclidean space.
2. Orthogonal sets, orthogonal projections, orthonormal basis, Gram-Schmidt process
3. Least square approximations
4. Orthogonal matrix, orthogonal diagonalization of a symmetric matrix.
5. Quadratic forms, matrix of a quadratic forms, transformation quadratic forms to canonical forms, quadratic lines and surfaces.

13. Reference:

1. S. Axler, *Linear Algebra Done Right*, (2ed, Springer,1997)
2. E.H. Connell, *Elements of abstract and linear algebra*, 2001, [http://www.math.miami.edu/_ec/book/]
3. S. Lipschutz, *Schaum's Outline of Theory and Problems of Linear Algebra*, (Schaum,1991) McGraw-hill, New York, 1991.
4. Gilbert Strang, *Introduction to Linear Algebra*, Wellesley-Cambridge Press, 1998.

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MI1046 Differential Equations and Series

1. Course Title: **Differential Equations and Series**

2. Course ID: MI1046

3. Course Units: **3(2-2-0-6)**

- Lecture: 30 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Second-year students in Undergraduate Advanced Programs or other students having good English skills.

6. Requisites

- Prerequisites: MI1026

7. Objectives and Expected Outcomes

Differential Equations and Series is intended for engineering students and others who require a working knowledge of differential equations and series; included are technique and applications of differential equations and infinite series. Since many physical laws and relations appear mathematically in the form of differential equations, such equations are of fundamental importance in engineering mathematics. Therefore, the main objective of this course is to help students to be familiar with various physical and geometrical problems that lead to differential equations and to provide students with the most important standard methods for solving such equations.

8. Description

First order separable, linear, and exact equations; second order linear equations, Laplace transforms, series solutions at an ordinary point, systems of first order linear equations, and applications.

9. Student Duties

- Class attendance is required: 2+2=4 hours/week
- Homework is assigned at each lecture hour
- Quizzes will be given 3 times per semester; Problems in Quizzes are taken from (or similar to) homeworks
- Midterm Exams: There will be two midterm exams per semester
- Final Exam: Problems in the final exam cover the main topics taught during the semester and require through review of all the material covered in the class....

10. Assessment

- Quizzes: 0.2 (20%)
- Mid-term exam: 0.3 (30%)
- Final exam: 0.5 (50%)

11. Course Materials

- Glenn Ledder, *Differential Equations: a Modeling Approach*, McGraw-hill, New York, 2005.

12. Course Topics

DIFFERENTIAL EQUATIONS AND SERIES

Course Developer: Dr. Nguyen Thieu Huy

PART ONE: SERIES (11+11)

I. Real series: (4+4)

1. Series, convergence and divergence, general terms, sums, partial sums, remainder.
2. Tests for convergence and divergence:
   +) Necessary condition for convergence, harmonic series.
   +) Cauchy's convergence principle; absolute convergence, conditional convergence.
   +) Comparison test, geometric series,
   +) Tests for absolute convergence: D'alembert (ratio) test, Cauchy's test, integral test, Riemann series.
   +) Leibniz test for series having terms with alternative signs.
3. Properties of convergent series:
   +) Algebraic sum of two convergent series.
   +) Changing order of terms and product of absolute convergent series

II. Series of real functions, power series: (4+4)

1. Series of real functions, regions of pointwise convergence, sum of series.
2. Uniform convergence, Cauchy's and Weierstrass tests for uniform convergence.
3. Properties of Uniformly convergent series of functions: Continuity, differentiation, Integration
4. Power series: Abel's theorem, radius of convergence, convergent interval.
5. Functions given by power series: termwise limits, termwise differentiation and integration.
6. Representation of functions by power series: Taylor's series, Maclaurin series, some important Taylor's series.

III. Fourier series: (3+3)

1. Trigonometric series, Fourier coefficients and series of a piecewise-continuous function.
2. Representation of functions by Fourier series of 2π-periodic functions: Dirichlet's theorem; Fourier series of odd or even functions.
3. Fourier series of $2l$-periodic functions and of functions defined on an interval (a,b).

PART TWO: DIFFERENTIAL EQUATIONS (19+19)

IV. Introduction to differential equations, basic concepts and technique: (3+3)

1. Natural decay and growth, Mathematical model.
2. Differential equations: solutions, existence and uniqueness of solutions; examples from physic, chemistry and ecology.
3. Separable first-order differential equations.
4. Approximation of solutions: Euler's and Runge-Kutta methods.

V. Homogeneous linear equations: (4+4)

1. Linear oscillator models: vibrating systems (e.g. vibration of a spring). Homogeneous linear equations.
2. Linear differential operators, linear independence of solutions, algorithm for solving homogeneous linear equations.
3. Homogeneous linear equations with constant coefficients: Characteristic equations and polynomials, wronskian, solutions.
4. Some other Homogeneous linear equations: Steady heat flow in a tube, Cauchy-Euler's equations, Bessel equation, aging spring problem.
5. Power series solutions.

VI. Nonhomogeneous linear equations: (4+4)

1. More on linear oscillator models: water flow and electric circuit.
2. General solutions for nonhomogeneous linear equations: Structure of solutions, method of variation of parameters.
3. First order linear equations: the integrating factor method and method of undetermined coefficients.
4. Variation of parameters for second-order equations.

VII. Laplace transform and applications: (4+4)

1. Unilateral Laplace transform for piecewise-continuous functions: Definition and properties. Tables of Laplace transform.
2. Laplace transform for initial-valued problems.
3. Impulsive forcing, Dirac delta function; convolution and Impulse respond functions.

VIII. Vibrating string: An introduction to partial differential equations: (5+3)

1. Transverse vibration of a string: wave equations.
2. Partial differential equations: Definition, more examples: heat equation, Laplace equation, signalling problem, travelling wave.
3. General solutions of the wave equations.
4. Vibration Modes of a finite or plucked string.
5. Solutions by Fourier series.

13. Reference:

1. Glenn Ledder, *Differential Equations: a Modeling Approach*, McGraw-hill, New York, 2005.
2. William E. Boyce, Richard C. DiPrima, *Elementary Differential Equations and Boundary*, John Wiley & Sons, Inc, New York, 2001.
3. Richard Bronson, *Differential Equations*, McGraw-hill, New York, 2003.

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MI2026 Introduction to Biostatistics

1. Course Title: **Introduction to Biostaticstics**

2. Course ID: MI2026

3. Course Units: **4(3-2-0-6)**

- Lecture: 45 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:

6. Requisites

- Prerequisites: - MI1026
- Corequisites: -

7. Objectives and Expected Outcomes

Course designed for the biomedical researcher, providing students with basic knowledge about statistics and biomedical application used for each topic.

Students must have ability to

- Analyse biomedical data including hypothesis testing, estimation, t-test, chi-squared test, regression, correlation, nonparametric test…

8. Description

Course designed for the biomedical researcher. Topics include: descriptive statistics, hypothesis testing, estimation, confidence intervals, t-tests, chi-squared tests, analysis of variance, linear regression, correlation, nonparametric tests, survival analysis and odds ratio. Biomedical applications used for each topic

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 15%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 35%

11. Course Materials

- *"Fundamentals of Biostatistics" 6th Edition* – Bernard Rosner – Brooks/Cole, ISBN: 978-0534418205

12. Course Topics

INTRODUCTION TO BIOSTATISTICS

Course Developer:

Chapter 1: General Overview

Chapter 2: Descriptive Statistics

2.1 Introduction
2.2 Measures of Location
2.3 Some Properties of Arithmetic Mean
2.4 Measures of Spread
2.5 Some Properties of the Variance and Standard Deviation
2.6 The Coefficient of Variation
2.7 Grouped Data
2.8 Graphic Methods
2.9 Case Study 1: Effects of Lead Exposure of Neurological and Psychological Function in Children
2.10 Case Study 2: Effects of Tobaco Use on Bone-Mineral Density in Middle-Aged Woman
2.11 Obtaining Descriptive Statistics on the Computer

Chapter 3: Probability

3.1 Introduction
3.2 Definition of Probability
3.3 Some Useful Probabilistic Notation
3.4 The Multiplication Law of Probability
3.5 The Addition Law of Probability
3.6 Conditional Probability
3.7 Baye's Rule and Screening Tests
3.8 Bayesian Inference
3.9 ROC Curves
3.10 Prevalance and Incidence

Chapter 4: Discrete Probability Distributions

4.1 Introduction
4.2 Random Variables
4.3 The Probability-Mass Function for a Discrete Random Variable
4.4 The Expected Value of a Discrete Random Variable
4.5 The Variance of a Discrete Random Variable
4.6 The Cummulative-Distribution Function of a Discrete Random Variable
4.7 Permutations and Combinations
4.8 The Binomial Distribution
4.9 Expected Value and Variance of the Binomial Distribution
4.10 The Poisson Distribution
4.11 Computation of Poisson Probabilities
4.12 Expected Value and Variance of the Poisson Distribution

4.13 Poisson Approximation to the Binomial Distribution

Chapter 5: Continuous Probability Distributions

5.1 Introduction
5.2 General Concepts
5.3 The Normal Distribution
5.4 Properties of the Standard Normal Distribution
5.5 Conversion from an $N(\mu, \sigma^2)$ Distribution to an N(0,1) Distribution
5.6 Linear Combinations of Random Variables
5.7 Normal Approximation to the Binomial Distribution
5.8 Normal Approximation to the Poisson Distribution

Chapter 6: Estimation

6.1 Introduction
6.2 The Relationship Between Population and Sample
6.3 Random-Number Tables
6.4 Randomized Clinical Trials
6.5 Estimation of the Mean of a Distribution
6.6 Case Study: Effects of Tobaco Use on Bone-Mineral Density in Middle-Aged Woman
6.7 Estimation of the Variance of a Distribution
6.8 Estimation of the Binomial Distribution
6.9 Estimation of the Poisson Distribution
6.10 One-Side Confidence Intervals

Chapter 7: Hypothesis Testing: One-Sample Inference

7.1 Introduction
7.2 General Concepts
7.3 One-Sample Test for the Mean of a Normal Distribution: One-Sided Alternatives
7.4 One-Sample Test for the Mean of a Normal Distribution: Two-Sided Alternatives
7.5 The Power of a Test
7.6 Sample-Size Determination
7.7 The Relationship Between Hypothesis Testing and Confidence Intervals
7.8 Bayesian Inference
7.9 One-Sample Test for χ^2 Test for the Variance of a Normal Distribution
7.10 One-Sample Test for a Binomial Distribution
7.11 One-Sample Inference for the Poisson Distrubution
7.12 Case Study: Effects of Tobaco Use on Bone-Mineral Density in Middle-Aged Woman

Chapter 8: Hypothesis Testing: Two-Sample Inference

8.1 Introduction
8.2 The Paired t Test
8.3 Interval Estimation for the Comparision of Means from Two Paired Samples
8.4 Two-Sample t Test for Independent Samples with Equal Variances
8.5 Interval Estimation for the Comparision of Means from Two Independent Samples (Equal Variance Case)
8.6 Testing for the Equality of Two Variances

8.7 Two-Sample t Test for Independent Samples with Unequal Variances
8.8 Case Study: Effects of Lead Exposure of Neurological and Psychological Function in Children
8.9 The Treament of Outliers
8.10 Estimation of Sample Size and Power for Comparing Two Means
8.11 Sample Size Estimation for the Longitudinal Studies

Chapter 9: Nonparametric Methods
9.1 Introduction
9.2 Sign Test
9.3 The Wilcoxon Signed-Rank Test
9.4 The Wilcoxon Rank-Sum Test
9.5 Case Study: Effects of Lead Exposure of Neurological and Psychological Function in Children

Chapter 10: Multisample Inference
10.1 Introduction to One-Way Analysis of Variance
10.2 One-Way Analysis of Variance – Fixed-Effect Model
10.3 Hypothesis Testing in One-Way ANOVA – Fixed-Effect Model
10.4 Comparision of Specific Group in One-Way ANOVA
10.5 Case Study: Effects of Lead Exposure of Neurological and Psychological Function in Children
10.6 Two-Way Analysis of Variance
10.7 The Kruskal-Wallis Test
10.8 One-Way ANOVA – Random-Effect Model
10.9 The Intraclass Correlation Coefficients

Chapter 11: Hypothesis Testing: Categorical Data
11.1 Introduction
11.2 Two-Sample Test for Binomial Proportions
11.3 Fisher's Exact Test
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11.5 Estimation of Sample Size and Power for Comparing Two Binomial Proportions
11.6 RxC Contingency Tables
11.7 Chi-Square Goodness-of-Fit Test
11.8 The Kappa Statistic

Chapter 12: Regression and Correlation Methods
12.1 Introduction
12.2 General Concepts
12.3 Fitting Regression Lines – The Method of Least Squares
12.4 Inferences About Parameters from Regression Lines
12.5 Interval Estimation for Linear Regression
12.6 Assessing the Goodness of Fit of Regression Lines
12.7 The Correlation Coefficients

12.8 Statistical Inference for Correlation Coefficients
12.9 Multiple Regression
12.10 Case Study: Effects of Lead Exposure of Neurological and Psychological Function in Children
12.11 Partial and Multiple Correlation
12.12 Rank Correlation

13. Lab works

14. References

1. *"Fundamentals of Biostatistics" 6th Edition* – Bernard Rosner – Brooks/Cole, ISBN: 978-0534418205
2. *"Principles of Biostatistics" 2nd Edition* – Marcello Pagano, Kimberlee Gauvreau – Duxbury Press, ISBN: 978-0534229023
3. *"Statistics for the Life Sciences" 3rd Edtion* – Myra Samuels, Jeffrey Witmer – Prentice Hall, ISBN: 978-0131228115

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PH1016 General Physics I

1. Course Title: **General Physics I**

2. Course ID: PH1016

3. Course Units: **4(2-2-1-8)**

- Lecture: 30 hours
- Seminar: 30 hours
- Lab: 6 x 2 hours

4. Replacement/Equivalent Courses:

5. Expected Participants: Second-year students in Undergraduate Advanced Programs or other first-year students having good English skills.

6. Requisites

- Prerequisites: - Math 220; Math 230/231
- Requisites: - English language level: Students are expected to be able to listen lectures and to read textbooks in English.
- Co-requisites: -

7. Objectives and Expected Outcomes

The goals of this part of the course are to provide students with the knowledge of the basis laws of classical mechanics, the conservation laws, vibration and mechanical waves, some concepts of the Einstein's theory of relativity, the methods of analyzing and solving relevant problems. The laboratory sessions help students to practice the skills at performing measurements of mass, length, time and some other mechanical quantities, evaluating their errors, setting up simple experiments to investigate topics in the studied lectures.

8. Description

Kinetics and dynamics of material point - Mechanical energy and field of potential energy - Dynamics of rigid - Vibration and mechanical waves - Einstein's relative Theory.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab work:
- ...

10. Assessment

- Mid-term grade: 0.4 (40%)
  - Home exercise grading
  - Project
  - Lab work and reports
  - Mid-tem test
- Final exam (multiple-choice and writing): 0.6 (60%)

11. Course Materials

- Textbook: "*University Physics with Modern Physics"*, Hugh D. Young, Roger A. Freedman
  Addison Wesley - 2004
- Lecture Notes
- Lab Manual

12. Course Topics

GENERAL PHYSICS I

Course Developers: - Nguyen Vien Tho
- Duong Huyen

Introduction: The nature of Physics - Standards and units

1 Kinetics of material point (lectures: 5 h + discussions and exercises: 5 h)

1.1 Motion in one dimension:

1.1.1 Average and instantaneous velocities

1.1.2 Average and instantaneous accelerations

1.1.3 Motion with constant acceleration

1.1.4 Freely falling motion

1.2 Motion in two and three dimensions:

1.2.1 Position and velocity vectors

1.2.2 Acceleration vector, tangent acceleration and normal acceleration vectors

1.2.3 Circular motion: angular velocity and acceleration, relations between angular velocity and linear velocity, between angular acceleration and tangent acceleration

2 Dynamics of material point (6 + 6)

2.1 Newtonian laws of motion:

2.1.1 Forces and interactions, Newton's first law, inertial frames of reference

2.1.2 Newton's second law superposition of forces, friction, tension

2.1.3 Newton's third law; action and reaction, examples of applying Newton's laws

2.1.4 Dynamics of circular motion, centripetal and centrifugal forces

2.2 Momentum and impulse:

2.2.1 Equation of Newton's second law in terms of momentum

2.2.2 Impulse-momentum theorem, conservation of momentum

2.2.3 Elastic and inelastic collisions, rocket propulsion

3 Mechanical energy and it's conservation (5 + 5)

3.1 Work and power:

3.1.1 Kinetic energy and work-energy theorem

3.1.2 Gravitational potential energy and theorem of potential energy in uniform gravitational field

3.1.3 conservation of mechanical energy

3.1.4 Problem-solving strategy using mechanical energy conservation

3.2 Potential energy of a force field:

3.2.1 Elastic potential energy, potential force field

3.2.2 Relation between force and potential energy in one dimension, in two and three dimensions

3.2.3 Potential energy diagram

3.3 Gravitational field:

3.3.1 Newton's law of gravitation

3.3.2 Gravitational potential energy

3.3.3 Motion of satellites, satellite orbits

4 Dynamics of rigid bodies (6 + 6)

4.1 Kinetics of rigid body:

4.1.1 Translation of rigid body, center of mass

4.1.2 Rotation of rigid body about a fixed axis

4.2 Moment of force and moment of inertia:

4.2.1 Moment of a force with respect to the rotation axis

4.2.2 Moment of inertia and calculation of moment of inertia

4.3 Angular momentum:

4.3.1 Angular moment of any system of particles, angular momentum of a rigid body rotating around a fixed axis

4.3.2 Theorems for angular momentum

4.3.3 Conservation of angular momentum, gyroscopes and precession

4.4 Work and power in rotational motion

4.4.1 Work done by a torque

4.4.2 Rotational kinetic energy of rigid bodies

5 Oscillations and mechanical waves (5 + 5)

5.1 Oscillations:

5.1.1 Periodic motion and oscillation, quantities describing oscillations, differential equation for (one-dimensional) oscillations

5.1.2 Harmonic oscillations and the connection with circular motion

5.1.3 Simple and physical pendulums

5.1.4 Damped oscillations, forced oscillations and resonance

5.1.5 Superposition of harmonic oscillations

5.2 Mechanical waves

5.2.1 Formation of a wave, mathematical description of a wave

5.2.2 Wave functions and quantities specifying a mechanical wave

5.2.3 Wave energy and intensity

6 Theory of relativity (3 + 3)

6.1 Relativity

6.1.1 Relativity in classical mechanics

6.1.2 Two postulates of Einstein's theory of relativity

6.1.3 Relativity of simultaneity, of time intervals and of lengths

6.2 Relativistic mechanics

6.2.1 Lorentz transformations

6.2.2 Relativistic mass and momentum

6.2.3 Einstein's relation of energy and consequences

13. Lab works

The topics will be chosen from the following list:

- Measurement of basic constants: length, weight and time
- Law of momentum using Air track
- Oscillation of physical pendulum (Reversible pendulum)
- Determine moment of inertia and bear friction

- Analyze the resonance of a pendulum using Data Studio program
- Determine sound velocity using standing wave method
- Determine sound velocity using a Quincke tube
- Determine sound velocity using Doppler method
- Determine sound velocity in a metal rod using transient Comex method
- Determine viscosity of liquid using Stock method

14. References

1. "*University Physics with Modern Physics"*, Hugh D. Young, Roger A. Freedman Addison Wesley - 2004
2. *"Physics for Scientists and Engineers"*, D. C. Giancoli, Prentice Hall -1999
3. *"Newtonian Physics"*, B. Crowell, The Light and Matter - 2002
4. *Conservation Laws"*, B. Crowell, The Light and Matter -2002
5. *"Vibrations and Waves"*, B. Crowell, The Light and Matter -2002

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PH1026 General Physics II

1. Course Title: **General Physics II**

2. Course ID: PH1026

3. Course Units: **4(3-2-1-8)**

- Lecture: 45 hours
- Seminar: 30 hours
- Lab: 6 x 2 hours

4. Replacement/Equivalent Courses:

5. Expected Participants: Second-year students in Undergraduate Advanced Programs or other first-year students having good English skills.

6. Requisites

- Prerequisites: - Math 220; Math 230/231; Ph1016
- Requisites: -
- Co-requisites: -

7. Objectives and Expected Outcomes

The goals of this part of the Course of General Physics are to provide students with the knowledge of the basis laws of electromagnetism, the way of describing electric and magnetic fields, as well as their interaction with matter, the methods of analyzing and solving relevant problems. At the end of the Course some knowledge of thermo-phenomena is incorporated which includes the molecular kinetic theory of gas and the three principles of thermodynamics. The laboratory sessions help students to practice the skills at performing measurements of electromagnetic quantities, setting up simple experiments to investigate topics in the studied lectures, analyzing experiment data to obtain conclusions, evaluating measurement errors.

8. Description

Static electrical field - Insulator - Conducting objects and capacitor - Magnetic field - Electromagnetic induction - Magnetic material - Electromagnetic oscillations and waves - Electromagnetic field - Molecular kinetic theory of gas - Principles of thermodynamics.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab work:

10. Assessment

- Mid-term grade: 0.4 (40%)
  - Home exercise grading
  - Project
  - Lab work and reports
  - Mid-tem test
- Final exam (multiple-choice and writing): 0.6 (60%)

11. Course Materials

- Textbook: "*University Physics with Modern Physics"*, Hugh D. Young, Roger A. Freedman Addison Wesley - 2004
- Lecture Notes
- Lab Manual

12. Course Topics

GENERAL PHYSICS II

Course Developers: - Nguyen Vien Tho
- Duong Huyen

1 Static electric field (lectures: 5 h + discussions and exercises: 4 h)

1.1 Electric forces and concept of electric field

1.1.1 Electric forces between electric charges - Coulomb's law

1.1.2 Electric field; field electric vector, electric field lines

1.1.3 Superposition of electric fields

1.1.4 Electric dipole, electric dipole moment

1.2 Gauss's law and applications

1.2.1 Electric flux, Gauss's law

1.2.2 Applying Gauss's law to calculate the electric field of point-like charge

1.2.3 Calculation of the electric field of planar, spherical and cylindrical distributions

1.3 Electric potential and electric potential difference

1.3.1 Electric potential energy in an electric field

1.3.2 Electric potential and electric potential difference. Calculating the electric potential

1.3.3 Relations between electric field vector and electric potential, potential gradient

1.3.4 Electric potential energy, equi-potential surfaces

2 Dielectrics (2 + 2)

2.1 Dielectrics

2.1.1 Dielectric constant of material

2.1.2 induced charge and polarization of dielectrics

2.2 Molecular model of induced charge

2.3 Piezoelectric effect

3 Conductors, capacitors (4 + 2)

3.1 Conductors

3.1.1 Conductors, charges on conductors

3.1.2 Electric field at the surfaces of a conductor; charging by induction

3.1.3 Capacitors, capacitance of conductors and capacitors

3,1,4 Capacitance of parallel-plate and cylindrical capacitors

3.2 Energy of charged conductors and of capacitors

3.2.1 Energy of a charged conductor

3.2.2 Energy of a system of charged conductors

3.2.3 Electric field energy

3.3 Constant electric current

3.3.1 Electric current, current density

3.3.2 Resistance of conductor, Ohm's law

3.3.3 Electromotive force (emf) and sources of emf

3.3.4 Non-electrostatic force and corresponding electric field

4 **Magnetic field** (5 + 4)

4.1 Magnetic forces and magnetic field

4.1.1 Magnetic forces of currents, concept of magnetic field

4.1.2 Magnetic field vector; magnetic field of a current element the law of Biot and Savar

4.1.3 Magnetic fields of a straight current-carrying conductor and of a circular current loop

4.2 Magnetic flux and Amper's law

4.2.1 Magnetic field lines and magnetic flux

4.2.2 Ampere's law on the line integral of magnetic field vector around a closed path

4.2.3 Applications of Amper's law in calculating the magnetic field of currents

4.3 Action of magnetic field on currents

4.3.1 Magnetic forces on a current-carrying conductor

4.3.2 Force and torque on a current-carrying loop in a uniform magnetic field

4.3.3 Work of magnetic force

4.3.4 Motion of charged particles in a magnetic field, Lorentz force

5 Electromagnetic induction (2 + 2)

5.1 Laws of electromagnetic induction

5.1.1 Induction experiments, Faraday's law and Lenz's law

5.1.2 Motional electromotive force

5.1.3 Induced electric field; eddy currents

5.2 Inductance

5.2.1 Mutual inductance and self-inductance

5.2.2 Self-induced emf

5.2.3 Energy stored in a inductor, magnetic field energy, magnetic energy density

6 Magnetic materials (2 + 1)

6.1 Magnetization in materials

6.1.1 Paramagnetism and diamagnetism

6.1.2 Atomic magnetic moment, Bohr magneton

6.1.3 Magnetization vector of material; relative permeability and permeability of material, magnetic susceptibility

6.2 Ferromagnetism

6.2.1 Magnetic domains

6.2.2 Saturation of magnetization, hysteresis loops

6.2.3 Ferrites and their properties

7 Electromagnetic oscillation, electromagnetic waves and field (6 + 3)

7.1 Oscillating circuits

7.1.1 L-C circuit and electrical oscillation

7.1.2 R-L-C circuit, damped harmonic motion

7.1.3 Underdamped, critically damped and overdamped circuits

7.1.4 R-LC circuit with a alternating current (ac) source, impedance of circuit, resonance in ac circuits

7.2 Maxwell's equations

7.2.1 The Maxwell's first statement on eddy electric field, the Maxwell-Faraday's equation

7.2.2 The Maxwell's second statement on displacement current, the Maxwell-Ampere's equation

7.2.3 The system of Maxwell's equations, the concept of electromagnetic field

7.2.4 Energy of electromagnetic field

7.3 Maxwell's equations and electromagnetic waves

7.3.1 Wave solutions of Maxwell's equation, features of electromagnetic waves

7.3.2 Derivation of the wave equation

7.3.3 Sinusoidal plane electromagnetic waves, polarization

7.3.4 Electromagnetic waves in matter; speed of propagation of em waves, index of refraction of matter

7.3.5 Energy and energy flow of em waves, Poynting vector; the electromagnetic spectrum

8 Kinetic-molecular theory of gases and distribution functions (5 + 3)

8.1 Kinetic-molecular model of an ideal gas

8.1.1 State variables and equation of state

8.1.2 Ideal gases, ideal-gas equation

8.1.3 Kinetic-molecular model of an ideal gas

8.1.4 Average translational kinetic energy of a gas molecule

8.2 Distribution functions

8.2.1 Distribution function of molecular speeds, the Maxwell-Boltzmann distribution

8.2.2 Average speed, root-main square speed and the most probable speed of a gas molecule

8.2.3 Molecular translational kinetic energy, principle of equipartition of energy

8.2.4 Distribution of number of molecules in their potential energy, the Boltzmann distribution

8.2.5 Degrees of freedom of a molecule; internal energy of ideal gases

9 The first law of thermodynamics (4 + 3)

9.1 Description of thermodynamic processes

9.1.1 Thermodynamic system and thermodynamic process

9.1.2 Heat and work; equilibrium states, paths between thermodynamic states

9.1.3 The first law of thermodynamics

9.2 Thermodynamic processes

9.2.1 Consideration of kinds of thermodynamic processes: adiabatic, isochoric, isobaric and isothermal processes

9.2.2 Heat capacities of an ideal gas

10 The second law of thermodynamics (5 + 4)

10.1 Statements of the second law of thermodynamics

10.1.1 Directions of thermodynamic processes, reversible and irreversible processes

10.1.2 Heat engines, thermal efficiency of an engine

10.1.3 The second law of thermodynamics: Kelvin-Planck statement and Clausius statement;

10.1.4 Workless refrigerators; the Carnot cycle and Carnot theorem

10.2 Quantitative expression of the second law of thermodynamics

10.2.1 Entropy, principle of increasing entropy

10.2.2 Entropy change in some processes of an ideal gas

10.2.3 Entropy change in reversible and irreversible processes, the meaning of the second law of thermodynamics

10.2.4 Chemical potentials, thermodynamic equilibrium conditions

11 Real gases and phase transitions (5 + 2)

11.1 State equation of real gases

11.1.1 Differences between ideal and real gases

11.1.2 Van der Waals equation of state, critical point

11.1.3 Joule-Thomson effect

11.2 Phase transition

11.2.1 Phases of matter, phase diagram, independent species

11.2.2 Gibb's phase rule, classification of phase transitions, the first-order transition, Clapeyron-Clausius equation the second-order transition

13. Lab works

The topics will be chosen from the following list:

- Determine charge-recharge of neon lamp
- Determine resistor using Wheaston bridge.
- Oscilloscope. Characterize RLC circuit using Oscilloscop.
- Determine e/m ratio of electron.
- Characterize coupled oscillating circuits.
- Forced electrical oscillation using Comex program.
- Milikent experiment. Determine electric charge of electron.
- Characterize electric circuits using Science Workshop Interface.
- Determine thermal capacity Cp/Cv ratio of air.

14. References

1. "*University Physics with Modern Physics"*, Hugh D. Young, Roger A. Freedman Addison Wesley - 2004

2. "Physics for Scientists and Engineers", D. C. Giancoli, Prentice Hall -1999

3. "Electricity and Magnetism", B. Crowell, The Light and Matter - 2002

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CH1016 General Chemistry

1. Course Title: **General Chemistry**

2. Course ID: CH1016

3. Course Units: **4(3-2-1-8)**

- Lecture: 45 hours
- Seminar: 30 hours
- Lab: 6 x 2 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Second-year students in Undergraduate Advanced Programs or other first-year students having good English skills.

6. Requisites

We expect students to have a good grasp of school chemistry or equivalent.

7. Objectives and Expected Outcomes

The goals of this part of the course are to provide students with the knowledges of atom structure, chemical bonds, molecular structure, the periodic variation in physical properties of elements, states of matter; the basic laws of thermodynamics to determine enthalpy of reactions, direct of reactions; chemical equilibrium as well as kinetic laws.

The laboratory sessions help students to practise the skills at performing measurments of physicochemical properties of some substances, investigation of chemical equilibrium in solution and studying on kinetic reation.

8. Description

Compositions of atoms and periodic table, chemical bond and molecular structure, collecting elements state, coordination compounds, thermodynamics of chemical reactions, dynamics of chemical reactions, solution.

9. Student Duties

- Lecture attendance is strongly encouraged although not required
- Seminar attendance: ≥ 80%
- Homework will be assigned for almost all the lectures, but will not be collected and graded. However, students should be able to show their homework during seminar when requested. Solutions will be provided.
- Lab work: The Lab sections start at the third week of the course. The laboratory portion of the course will consist of twelve 2-hour laboratories, each involving a series of activities, including (i) conducting experiments to investigate topics you've studied in class, (II) analyzing your experimental results, and (III) writing a report on the obtained results. All labs will require completion of pre-labs which are to be handed in at the beginning of the relevant lab section. The experimental report will be graded by “satisfy” or “unsatisfied”. A student with two unsatisfied reports will be forbidden to attend a final exam.

10. Assessment

- Mid-term grade: 30% of the total grade
  One hour long test will be given in the mid-term.
- Final exam (writing)**:** 70% of the total grade
  Problems in final exam cover the main topics taught during the semester and require a thorough review of all the materials covered in class.

11. Course Materials

- Textbook:

1. Chemistry, *6th Edition, Raymond Chang*
2. Chemical principles, *5th Edition., Steven S.*Zumdahl
3. Chemistry: Principles and Reactions, *5th Edition, William L. Masterton*

- Lecture Notes:
- Lab Manual...

12. Course Topics

GENERAL CHEMISTRY

Course Developer: Dr. Nguyen Kim Nga
Dr. Tran Dai Lam

Part I: Fundamentals of chemical compositions

Chapter 1: Compositions of atoms and periodic table

1.1. Components of the atom
1.2. The atomic theory of Boh'rs
1.3. The principles of quantum mechanics
  1.3.1. The wave nature of the electron
  1.3.2. The uncertainty principle
  1.3.3. The quantum mechanical picture of the atom
    1.3.3.1. Wave function
    1.3.3.2. Schrodinger wave equation
1.4. The solution of the Schrodinger equation for one electron species
  1.4.1. Quantum numbers
  1.4.2. Atomic orbitals
1.5. Electron configurations:
  1.5.1. The shielding effect in many- electron atoms
  1.5.2. The general rules for arranging electrons to atomic orbitals
1.6. Period 's law and periodic table
  1.6.1. The periodic table and electron structure of atoms in periodic table
  1.6.2. Periodic variation in physical properties
1.7. Coordination compounds

Chapter 2: Chemical bond and molecular structure

2.1. Fundamental notions of the chemical bond
  2.1.1. Bond energy
  2.1.2. Bond length
  2.1.3. Bond angle
2.2. Fundamental types of chemical bonding
  2.2.1. Covalent bonding
  2.2.2. Ionic bonding
2.3. Valence bond theory
2.4. Hybridization of atomic orbitals and geometric shape of molecular
2.5. Molecular orbital theory

Chapter 3: Collecting elements state

3.1. Gas state
  3.1.1. State equation of ideal gas
  3.1.2. State equation of real gas
3.2. Liquid state
  3.2.1. General character
  3.2.2. Intermolecular forces
  3.2.3. Propeties of liquid

3.3. Solid state

3.3.1. Crystal and amorphous solid

3.3.2. Structure of crystals

3.3.3. Bonding in solids

3..3.4. Domain theory

Part II: Fundamental laws of chemical processes

Chapter 1: Thermodynamics of chemical reactions

1.1. Principles of heat flow

1.1.1. System and surroundings

1.1.2. State propeties

1.1.3. Direct and sign of heat flow

1.2. The first law of thermodynamics

1.2.1. Heat, work and Internal energy

1.2.2. The statement of the first law of thermodynamics

1.2.3. Enthalpy

1.3. The application of the first law of thermodynamics to chemistry. Enthalpy (heat) of reaction

1.3.1. Enthalpy (heat) of reaction

1.3.2. Entalpy (heat) of formation

1.3.3. Enthalpy (heat) of transition

1.4. Hess's law

1.5. Energy of chemical bond

1.5.1. The energy of dissociation of diatomic molecules

1.5.2. The energy of conversion of an atom into an ion (ionnization energy)

1.5.3. Bond energy

1.6. The second law of themordynamics

1.6.1. Spontaneous process and entropy

1.6.2. Entropy

1.7. Gibbs free energy

1.7.1. Standard free energy changes

1.7.1. Relation among the changes of Gibbs free energy, entanpy and entropy and direction of chemical reactions

1.8. Chemical equilibrium

1.8.1. Constant equilibrium

1.8.2. Transferring chemical equilibrium

1.8.3. Phase equilibrium

Chapter 2: Dynamics of chemical reactions

2.1. The rate of a chemical reaction

2.2. Influence of concentrations of reactants to the rate of a chemical reaction and the law of mass action

2.3. Temperature dependence of the rate and activation energy

2.4. Catalyst

2.4.1. Heterogeneous catalysis

2.4.2. Homogeneous catalysis
2.4.3. Enzym catalysis
2.4.4. Reaction mechanisms
2.5. Chain reaction (photochemical reaction)

Chapter 3: Solution

3.1. Concentration units
3.2. Principles of solubility
3.2.1. Solute-solvent interactions
3.2.2. Effect of temperature on solubility
3.2.3. Effect of pressure on solubility
3.3. Propeties of solution of no electrolytic dissociation substances
3.4. Propeties of solution of electrolytic dissociation substances
3.5. Chemical equilibrium in acid-base solution
3.5.1. Brönsted acid-base theory
3.5.2. The acid-base propeties of water
3.5.3. pH- a measure of acidity
3.5.4. Strength of acids and bases
3.6. Lewis acids and bases
3.7. Chemical equilibrium in solution of no soluble electrolytic dissociate substance
3.7.1. Solubility product constant
3.7.2. Predicting precipitation reactions
3.7.3. Separation of ions by fractional precipitation
3.7.4. The common ion effect and solubility

13. Lab works

- Introduction to the glass instruments in the lab
- Study on chemical equilibrium
- The influence of several factors on the rate of reactions
- Determination of the order of the reaction by UV-VIS method
- Determination of ionization acid constant of CH_3COOH by pH measuring method
- Determination of solubility product constant of $CaSO_4$

14. References

1. Chemistry, *6th Edition, Raymond Chang*
2. Chemical principles, *5th Edition., Steven S.*Zumdahl
3. Chemistry: Principles and Reactions, *5th Edition, William L. Masterton*
4. General and Inorganic Chemistry, *2nd Edition, N.S. Akhmetov (Translated from the Russian)*

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BF1016 Introductory Biology

1. Course Title: **Introductory Biology**

2. Course ID: BF1016

3. Course Units: **5(3-1-1-10)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

Addresses concepts in cellular and molecular biology, genetics, evolution and diversity of organisms. Emphasis is placed on learning, understanding and being able to use key biological concepts and the scientific method.

The lectures examine key concepts. Discussions allow students to more fully investigate these. In the laboratory, students will use the scientific method and apply a number of the concepts from lecture to carry out various experiments. In addition, labs stress the development of written and oral presentation skills. These are required to successfully communicate scientific concepts and students' research findings to others.

This course is designed to improve students' abilities to think, work and write scientifically. This means that, the students will be provided with real life, open-ended questions to investigate. Such questions generally have no single right answer. In the labs, each experiment provides some information about the question and perhaps more importantly leads the students to additional questions that could be investigated.

8. Description

First semester of a two semester course designed for majors in biological sciences. Topics include: cell structure and function, cellular metabolism (enzymes, respiration, photosynthesis), information flow (DNA, RNA, protein), principles of genetics and a survey of the five major kingdoms of organisms.

9. Student Duties

- Class attendance: ≥ 80%
- Discussion:
- Lab work:

10. Assessment

- Lab work: 20%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- Final exam: 40%

11. Course Materials

- *"Biology"* - Robert J. Brooker, Eric P. Widmaier, Linda Graham, and Peter Stiling – McGraw-Hill, ISBN: 978-0073268071

12. Course Topics

INTRODUCTORY BIOLOGY

Course Developer:

Chapter 1. An Introduction to Biology

1.1. The Properties of Life: Past and Present
1.2. Biology as a Scientific Discipline

Chapter 2. The Chemical Basis of Life

2.1. Atoms
2.2. Chemical Bonds and Molecules
2.3. Properties of Water
2.4. The Carbon Atom and the Study of Organic Molecules
2.5. Classes of Organic Molecules and Macromolecules

Chapter 3. Nucleic Acid Structure and DNA

3.1. Biochemical Identification of the Genetic Material
3.2. Nucleic Acid Structure
3.3. DNA Replication
3.4. Gene Expression at the Molecular Level
    3.4.1. Overview of Gene Expression
    3.4.2. Transcription
    3.4.3. RNA Processing in Eukaryotes
    3.4.4. Translation and the Genetic Code
    3.4.5. The Machinery of Translation
    3.4.6. The Stages of Translation
3.5. Gene Regulation
    3.5.1. Overview of Gene Regulation
    3.5.2. Regulation of Transcription in Bacteria
    3.5.3. Regulation of Transcription in Eukaryotes
    3.5.4. Regulation of RNA Processing and Translation in Eukaryotes
3.6. Mutation, DNA Repair, and Cancer
    3.6.1. Mutation
    3.6.2. DNA Repair
    3.6.3. Cancer

Chapter 4. Eukaryotic Chromosomes, Mitosis, and Meiosis

4.1. Molecular Structure of Eukaryotic Chromosomes
4.2. Mitotic Cell Division
4.3. Meiosis and Sexual Reproduction
4.4. Variation in Chromosome Structure and Number

Chapter 5. Simple Patterns of Inheritance

5.1. Mendel's Laws and the Chromosome Theory of Inheritance
5.2. Sex Chromosomes and X-Linked Inheritance Patterns
5.3. Variations in Inheritance Patterns and Their Molecular Basis
5.4. X Inactivation, Genomic Imprinting, and Maternal Effect

Chapter 6. Enzymes, Metabolism, and Cellular Respiration
6.1. Energy, Chemical Reactions, and Enzymes
6.2. Overview of Metabolism
6.3. Cellular Respiration

Chapter 7. Introduction to Animal Form and Functions
7.1. Organization of Animal Body
7.2. The Relationship Between Structure and Function
7.3. Homeostasis

Chapter 8. Nutrition, Digestion and Absorption
8.3. Principles of Digestion and Absorption of Food
8.4. Overview of Vertebrate Digestive Systems
8.5. Mechanisms of Digestion and Absorption in Vertebrates
8.6. Regulation of the Absorptive and Postabsorptive States
8.7. Energy Expenditure

Chapter 9. Circulation and Gas Exchange
9.1. Gastrovascular Cavities
9.2. Open Circulatory Systems
9.3. Closed Circulatory Systems
9.4. Types of Respiratory Organs
9.5. Design and Function of Mammalian and Avian Respiratory Systems
9.6. Control of Ventilation in Mammalian Lungs
9.7. Mechanisms of Oxygen Transport in Blood
9.8. Adaptations to Extreme Conditions
9.9. Impact on Public Health

Chapter 10. Excretory Systems and Salt and Water Balance
10.1. Principles of Homeostasis of Internal Fluids
10.2. A Survey of Excretory Organs
10.3. Structure and Function of the Mammalian Kidney
10.4. Impact on Public Health

Chapter 11. Neuroscience
11.1. The Evolution and Development of Nervous Systems
11.2. Structure and Function of the Human Nervous System
11.3. Cellular Components of Nervous Systems
11.4. Electrical Properties of Neurons
11.5. Communication Between Neurons
11.6. Impact on Public Health

Chapter 12. Endocrine Systems
12.1. Mechanisms of Hormone Action and Control

12.2. Links Between the Endocrine and Nervous Systems
12.3. Control of Metabolism and Energy Balance by Hormones
12.4. Hormonal Control of Reproduction

Chapter 13. Defense Mechanisms of the Body
13.1. Types of Pathogens
13.2. Nonspecific (Innate) Immunity
13.3. Specific (Acquired) Immunity
13.4. Impact on Public Health

Chapter 14. Behavioral Ecology
14.1. The Impact of Genetics and Learning on Behavior
14.2. Communication
14.3. Mating Systems

Chapter 15. Evolution and Speciation
15.1. Introdcution to Evolution
    15.1.1. The Theory of Evolution
    15.1.2. Observations of Evolutionary Change
    15.1.3. The Molecular Processes That Underlie Evolution
15.2. Population Genetics
    15.2.1. Genes in Populations
    15.2.2. Evolutionary Mechanisms and Their Effects on Populations
15.3. Origin of Species
15.3.1. Species Concepts
15.3.2. Mechanisms of Speciation
15.3.3. The Pace of Speciation
15.3.4. Evo-Devo: Evolutionary Developmental Biology and the Form of New Species

Chapter 16. Population Growth and Species Interaction
16.1 Polulation Ecology
    16.1.1. Understanding Populations
    16.2.2. How Populations Grow
    16.2.3. Human Population Growth
16.2. Species Interactions
    16.2.1. Competition
    16.2.2. Predation, Herbivory, and Parasitism
    16.2.3. Mutualism and Commensalism
    16.2.4. Conceptual Models

Chapter 17. Ecosystems Ecology
17.1. Food Webs and Energy Flow
17.2. Energy Production in Ecosystems
17.3. Biogeochemical Cycles

13. Lab works:

6 x 3 hour-lab

14. Refernces

1. *"Biology"* - Robert J. Brooker, Eric P. Widmaier, Linda Graham, and Peter Stiling – McGraw-Hill, ISBN: 978-0073268071
2. *"Human Biology: Concepts and Current Issues" 4th Edition* - Michael D. Johnson – Benjamin Cummings, ISBN: 978-0805394269
3. *"Human Biology" 7th Edition* - Cecie Starr and Beverly McMillan - Brooks Cole, ISBN: 978-0495015963
4. *"Biology: Concepts & Connections" 5th Edition* – Neil A. Campbell, Jane B. Reece, Martha R. Taylor, Eric J. Simon – Benjamin Cummings, ISBN: 978-0805371604
5. *"Biology" 7th Edition* – Peter H Raven, George B Johnson, Susan Singer, Jonathan Losos – McGraw-Hill, ISBN: 978-0072921649

Chairman of the Scientific and Education Council

FL3576 Basic Communication

1. Course Title: **Basic Communication**

2. Course ID: FL3576

3. Course Units: **2(2-1-0-4)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Students are expected to have a reasonable facility in standard English speaking, reading, and writing. Foreign students will have to have taken the required English as a Second Language courses, or they must have a passing grade on the TOEFL

6. Requisites

- Prerequisites: - FL1026-1029
- Corequisites: -

7. Objectives and Expected Outcomes

Emphasis on writing and critical reading. Planning, preparing, and revising informative and persuasive communication; adapting writing for intended audiences; grammar, usage and style; critical reading of prose models in the sciences and humanities; using information resources; videotaped oral presentations; collaborative writing using computers

By the end of this course, students should be able to:

- Read critically and analyze writing to locate the thesis, the pattern of organization, and the strengths and weaknesses of the writing.

- Plan, develop, and revise essays, suitable for a university setting, that present and defend a clear, precise thesis using effective organization and logic, appeals, evidence, a variety of sources, and appropriate documentation and that demonstrate a mastery of elements of grammar, usage, and style.

- Analyze the context of different communication situations and audience needs, interests, and values in order to adapt writing and speaking more effectively for their intended audiences.

- Speak with more confidence in front of peers in an organized manner and participate effectively in class discussions.

- Collaborate with fellow students to develop effective essays and presentations through group work and the peer review process.

8. Description

Emphasis on writing and critical reading. Planning, preparing, and revising informative and persuasive communication; adapting writing for intended audiences; grammar, usage and style; critical reading of prose models in the sciences and humanities; using information resources; videotaped oral presentations; collaborative writing using computers

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 15%

- 1st essay: 15%
- 2nd essay: 15%
- 3rd essay: 30%
- Presentation: 25%

11. Course Materials

- "*Academic Writer's Handbook*" 2nd Edition – W. H. Hayt, J. E. Kemmerly, S. M. Durbin – Longman, ISBN: 978-0205661787

12. Course Topics

BASIC COMMUNICATIONS

Course Developer:

CHAPTER 1. THE WRITING PROCESS.

1.1. What Is Academic Writing?
- 1.1.1 What is the proper subject of academic writing?
- 1.1.2 Characteristics of academic writing.

1.2. Preparing to Write in an Academic Setting.
- 1.2.1 Understanding your assignment.
- 1.2.2 Generating ideas and information.
- 1.2.3 Selecting, organizing, expanding information.

1.3. Writing a Working Thesis and a First Draft.
- 1.3.1 Writing a working thesis.
- 1.3.2 Writing a first draft.
- 1.3.3 Sample student paper: first draft.

1.4. Revising the Paper.
- 1.4.1 Global revision: bringing your main ideas into focus.
- 1.4.2 Section-level revision: developing your main idea.
- 1.4.3 Sentence-level revision.
- 1.4.4 Responding to editorial advice from peers and instructors.
- 1.4.5 Sample student paper: final draft “keep the laptops, change the teaching”

1.5. Paragraphs: Building Blocks of Academic Writing.
- 1.5.1 Unity: giving each paragraph a controlling idea and sticking to it.
- 1.5.2 Coherence: moving from sentence to sentence with a plan.
- 1.5.3 Developing the content of paragraphs.
- 1.5.4 Writing and revising introductions and conclusions.

CHAPTER 2. WORKING WITH INDIVIDUAL SOURCES.

2.1. Understanding and Evaluating Print Sources.
- 2.1.1 Understanding print sources.
- 2.1.2 Evaluating print sources.
- 2.1.3 Example evaluation.
- 2.1.4 Reading sources carefully.

2.2. Understanding and Evaluating Web Sites and Images.
- 2.2.1 Understanding web sites.
- 2.2.2 Evaluating web sites.
- 2.2.3 Understanding images.

2.3. Summarizing, Paraphrasing, and Quoting Sources.
- 2.3.1 Referring to sources.
- 2.3.2 Summarizing and paraphrasing sources.
- 2.3.3 Quoting sources.
- 2.3.4 Altering quotations.
- 2.3.5 Weaving summaries, paraphrases, and quotations into your paragraphs.

2.4. Avoiding Plagiarism.

2.4.1 Citing sources.
2.4.2 Causes of plagiarism.
2.4.3 Rules for avoiding plagiarism.
2.4.4 Determining common knowledge.
2.4.5 Plagiarism and the internet.
2.4.6 Collaborating and plagiarism.

CHAPTER 3. RESEARCH: LOCATING AND SYNTHESIZING MULTIPLE SOURCES.

3.1 The Research Process
Defining the task: topic, purpose, and audience.
Identifying your research question.
Generating a plan for research.
Devising a working thesis and writing a draft.
Record-keeping: creating a working bibliography.

3.2 Locating Electronic and Print Sources.
Reviewing sources for preliminary research and reading.
Focusing your research.
Locating sources on the web.
Additional web sites for researchers.
Bringing your research to an end.

3.3 Synthesizing Sources.
Understanding your purpose for synthesizing sources.
Creating an index to your sources.
Building the paper by working with your index.
Demonstration synthesis: building a source-based paper

CHAPTER 4. WRITING IN THE SCIENCES.

4.1 Areas of interest.
4.2 Writing in the sciences.
4.3 Making oral presentations.

CHAPTER 5. LIBRARY OF ACADEMIC WRITING.

5.1. Summary.
5.1.1 Summary defined.
5.1.2 Preparing for summary.
5.1.3 Writing the summary.
5.1.4 Example summary in the humanities.
5.1.5 Example summary in the social sciences.

5.2. Argument.
5.2.1 Academic argument defined
5.2.2 Making a claim.
5.2.3 Establishing yourself as trustworthy.
5.2.4 Supporting your claim with logical reasons.
5.2.5 Supporting your claim with emotional reasons.

5.2.5 Avoiding fallacies of evidence and logic.
5.2.6 Responding to counterarguments.
5.2.7 Writing your argument.
5.2.8 Example argument in the sciences.
5.2.9 Example argument in the humanities.
5.3. Analysis.
5.3.1 Analysis defined.
5.3.2 Planning and writing the paper.
5.3.3 Measures of a successful analysis.
5.3.4 Example analysis in the social sciences.
5.3.5 Example analysis in the sciences.
5.4. Critique.
5.4.1 Critique defined.
5.4.2 Critiques as part of a larger paper.
5.4.3 Planning and writing a paper-length critique.
5.4.4 Example critique in the humanities.
5.4.5 Example critique in the social sciences.

CHAPTER 6. EDITING FOR CORRECTNESS.
6.1. Constructing Sentences.
6.1.1 The five basic sentence patterns.
6.1.2 Sentence parts.
6.1.3 Phrases.
6.1.4 Clauses.
6.1.5 Sentence clarification.
6.2. Correcting Sentence Fragments.
6.2.1 Dependent clauses.
6.2.2 Phrases.
6.2.3 Repeating structures or compound predicates.
6.3. Correcting Comma Splices and Fused Sentences.
6.3.1 Common circumstances for fused sentences and comma splices.
6.3.2 Five ways of correcting fused sentences and comma splices.
6.4. Using Verbs.
6.4.1 Consistent use of principal verb parts.
6.4.2 Irregular verb forms.
6.4.3 Auxiliary verbs.
6.4.4 Transitive and intransitive verbs.
6.4.5 Verb tense.
6.4.6 Verb tense sequencing.
6.4.7 Active and passive voices.
6.4.8 The uses of mood.
6.5. Correcting Errors in Subject-Verb Agreement.
6.5.1 Third-person subject number and verb agreement.
6.5.2 Singular or plural third-person subject and verb.
6.6. Using Adjectives and Adverbs.

6.6.1 Adjectives and adverbs.
6.6.2 Adjectives and linking verbs.
6.6.3 Comparative and superlative forms of adjectives and adverbs.
6.6.4 Comparative and superlative relationships.
6.6.5 Double comparisons, double superlatives, and double negatives.
6.6.6 Past and present participles as adjectives
6.7. Correcting Misplaced and Dangling Modifiers.
6.7.1 Modifiers and the words they should modify.
6.7.2 Limiting modifiers.
6.7.3 Squinting modifiers.
6.7.4 Disruptive modifiers.
6.7.5 Avoiding dangling modifiers.
6.8. Using Nouns and Pronouns.
6.8.1 Pronouns as subjects.
6.8.2 Pronouns as objects.
6.8.3 Possessive nouns and pronouns.
6.8.4 Pronouns in the objective or subjective case in compound constructions .
6.8.5 Pronouns paired with a noun.
6.8.6 Appropriate pronoun case (whose, who, whom, whoever, whomever).
6.8.7 Pronoun case and comparison.
6.9. Correcting Errors in Pronoun-Antecedent Agreement.
6.9.1 Pronouns-antecedent agreement.
6.9.2 Clear pronoun reference.
6.10. Correcting Errors in Consistency.
6.10.1 Shifts in person and number.
6.10.2 Shifts in tense, mood, and voice.
6.10.3 Consistent use of direct or indirect discourse.
6.10.4 Clear, grammatical relations between sentence parts.
6.10.5 Consistent relations between subjects and predicates
6.10.6 Constructions with missing words.
6.10.7 Consistent, complete, and clear comparisons.
6.11. Correcting Faulty Parallelism.
6.11.1 Parallel words, phrases, and clauses with coordinating conjunctions: and, but, for, or, nor, so, yet.
6.11.2 Parallelism with correlative conjunctions: either/or, neither/nor, both/and, not only/but also.
6.11.3 Parallelism in sentences with compared and contrasted elements.

CHAPTER 7. EDITING FOR CLARITY AND EMPHASIS.

7.1. Clear, Concise, and Direct Sentences.
7.1.1 Wordiness.
7.1.2 Strong verbs.
7.2. Building Emphasis with Coordination and Subordination.
7.2.1 Coordinating conjunctions (and/but) and conjunctive adverbs (consequently).
7.2.2 Subordinating conjunctions (while, when, because).

7.2.3 Mixing coordination and subordination for sentence variety.

7.3. Choosing the Right Word.

7.3.1 Dictionary entries.

7.3.2 Vocabulary building.

7.3.3 The impact of word choices.

7.3.4 Setting a tone for your papers.

7.3.5 Biased, dehumanizing language.

CHAPTER 8. PUNCTUATION.

8.1. Using End Punctuation.

8.1.1 The period.

8.1.2 The question mark.

8.1.3 The exclamation point.

8.2. Using Commas.

8.2.1 Commas with introductory and concluding expressions.

8.2.2 Commas before a coordinating conjunctions.

8.2.3 Commas between items in a series.

8.2.4 Commas to set off nonsequential elements.

8.2.5 Conventions of quoting, naming, and various forms of separation.

8.2.6 Misuse or overuse of commas.

8.3. Using Semicolons.

8.3.1 Linking independent clauses.

8.3.2 Linking independent clauses with a conjunctive adverb (however, therefore).

8.3.3 Linking independent clauses with a coordinating conjunction (and, but).

8.3.4 Separating items in a series.

8.3.5 Quotation marks and semicolons.

8.4. Using Apostrophes.

8.4.1 Possession with nouns and pronouns.

8.4.2 Contractions marking the omission of letters and numbers.

8.4.3 Plural forms of letters, numbers, and symbols.

8.5. Using Quotation Marks.

8.5.1 Direct quotations.

8.5.2 Dialogue and other material.

8.5.3 Misuse or overuse of quotation marks.

8.6. Using Other Marks.

8.6.1 The colon.

8.6.2 Dashes for emphasis.

8.6.3 Parentheses to set off nonessential information.

8.6.4 Brackets for editorial clarification.

8.6.5 Ellipses to indicate a break in continuity.

8.6.6 The slash.

CHAPTER 9. MECHANICS AND SPELLING.

9.1. Using Capitals.

9.1.1 The first letter of the first word in every sentence.

9.1.2 Words of significance in a title.
9.1.3 The first word in every line of poetry, according to conventions.
9.1.4 Proper nouns.

9.2. Using Italics.
9.2.1 Words for specific emphasis.
9.2.2 Words, letters, and numbers to be defined or identified.
9.2.3 Titles of book-length works.

9.3. Using Abbreviations.
9.3.1 Titles of rank both before and after proper names.
9.3.2 Specific dates and numbers.
9.3.3 Acronyms, uppercase abbreviations, and corporate abbreviations.
9.3.4 Parenthetical and bibliographic references.
9.3.5 Misuse of abbreviations.

9.4. Using Numbers in Writing.
9.4.1 Numbers that begin sentences and one- or two-word numbers.
9.4.2 Conventional use of numbers.

9.5. Using Hyphens.
9.5.1 Compound words.
9.5.2 Word divisions at the end of a line.

9.6. Making Spelling Decisions.
9.6.1 Homonyms and commonly confused words.
9.6.2 Basic rules for ie/ei.
9.6.3 Rules for using prefixes.
9.6.4 Rules for using suffixes.
9.6.5 Rules for forming plurals.

13. Lab works:

14. References

1. *"Academic Writer's Handbook" 2nd Edition* – W. H. Hayt, J. E. Kemmerly, S. M. Durbin – Longman, ISBN: 978-0205661787
2. *"Allyn & Bacon Handbook" 5th Edition* – Leonard J. Rosen, Laurence Behrens – Longman, ISBN: 978-0321202468
3. *"Scott Foresman Handbook for Writers" 8th Edition* – John Ruszkiewicz, Christy Friend, Maxine Hairston – Prentice Hall, ISBN: 978-0132370035
4. *"MLA Handbook for Writers of Research Papers" 6th Edition* – Joseph Gibaldi – Modern Language Association of America, ISBN: 978-0873529860
5. *"Writers Inc.: A Student Handbook for Writing And Learning"* – Sebranek, Patrick Sebranek, Dave Kemper, Verne Meyer – Great Source Education Group, ISBN: 978-0669529951

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FL3586 Technical Communication

1. Course Title: **Technical Communication**

2. Course ID: FL3586

3. Course Units: **3(2-2-0-6)**

- Lecture: 30 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Students must have the ability to: Read and think critically; Write essays suitable for a university setting; Adapt speech and writing for intended audiences; Speak and present with confidence in front of peers; Analyze and explain the strengths and weaknesses of written documents and oral presentations; Collaborate with others in communication projects; Understand the basics of personal computers and computer networks, Microsoft Word, PowerPoint, web browsers, and internet search engines.

6. Requisites

- Prerequisites: - FL3576
- Corequisites: -

7. Objectives and Expected Outcomes

By the end of this course, students should be able to:

- Write effective technical and research reports, proposals, procedures, memoranda, process explanations, and/or professional correspondence aimed at an interdisciplinary audience.
- Prepare and deliver professional presentations and briefings, in a style suitable for future engineering design courses and the workplace, using visual aids and computer technology.
- Identify, retrieve, and critically analyze technical information through library research, computer databases, and online networks.
- Review and revise written and oral communication.
- Develop, integrate, and edit tables, charts, and diagrams.
- Work productively in a team, with emphasis on group process, decision making strategies, project planning, and peer review.
- Make thoughtful, well-informed career choices.
- Understand contemporary issues in engineering and the economic, environmental, political, and societal impacts of engineering decisions.
- Understand the ethical responsibilities of providing accurate information and communicating effectively with both the general public and professionals.

8. Description

Communication for engineering, science, and technology; theory and practice in planning, preparing, and critiquing reports, proposals, instructions, and business correspondence; research strategies, collaborative work; oral presentations

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Class attendant: 10%

- Writng proposals: 20%
- Writing memos: 10%
- Writng reports: 35%
- Writing presentations: 15%
- Presentation: 10%

11. Course Materials

- *"Technical Communication: A Reader-Centered Approach" 6th Edition* – Paul V. Anderson – Wadsworth Publishing, ISBN: 9781413017700

12. Course Topics

TECHNICAL COMMUNICATIONS

Course Developer:

Chapter 1: Introduction
1.1 Problem-Solving Strategies for Technical Communicators
1.2 Analyzing Your Audience
1.3 Specific Planning Techniques: Outlining
1.4 Storyboarding: Making Planning Concrete
1.5 Creating an International User Analysis

Chapter 2: Researching
2.1 Researching
2.2 Finding and Evaluating Sources
2.3 How to Evaluate Sources
2.4 Evaluating Internet Resources
2.5 Planning and Conducting Interviews
2.6 Designing Questionnaires
2.7 Documenting Sources

Chapter 3: Organizing for Readers
3.1 Setting Reader Expectations (Frontloading)
3.2 Reader Cues
3.3 Dividing Information into Units (Chunking)
3.4 Organizational Strategies
3.5 Paragraphing Effectively

Chapter 4: Designing the Document: Format and Graphics
4.1 Strategies in Visual Communication
4.2 Designing Readable Hardcopy Pages
4.3 Techniques in Formatting Textual Elements
4.4 Purposes of Graphic Illustrations
4.5 The Ethics of Graphics
4.6 Using Graphics on the World Wide Web
4.7 Tips for International Communication

Chapter 5: Editing for Style
5.1 Style Sheets and Guidelines
5.2 Creating a Readable Style
5.3 Avoiding Agentless Prose
5.4 Writing Smooth Transitions
5.5 Tips for International Communication

Chapter 6: Collaborating on Writing Projects
6.1 The Collaborative Process
6.2 Writing, Usability Testing, and Editing Phase

6.3 Peer Editing
6.4 Electronic Collaboration
6.5 Conducting Productive Meetings

Chapter 7: Considering Ethical and Liability Issues
7.1 Social Responsibility
7.2 Guidelines for Ethical Choices
7.3 Information Liability
7.4 Liability in Writing Safety Information
7.5 Employee Handbooks
7.6 Understanding Intellectual Property Law

Chapter 8: Memos, Letters, and E-mail Correspondence
8.1 Comparing Correspondence Modes
8.2 Determining Your Purpose
8.3 E-mail
8.4 Guidelines for Writing E-mail
8.5 Tips for International Communication

Chapter 9: Instructions, Procedures, and Policies
9.1 Types of Instructions and Procedures
9.2 Analyzing Your Audience
9.3 Organizing
9.4 Testing for Usability
9.5 Informal Observations and Interviews

Chapter 10: Describing and Summarizing Technical Information
10.1 Analyzing Your Audience
10.2 Organizing Descriptions and Summaries
10.3 Describing a Technical Object or Mechanism
10.4 Describing a Technical Process
10.5 Organizing Technical Summaries

Chapter 11: Abstracts and Executive Summaries
11.1 Abstracts
11.2 Executive Summaries
11.3 Analyzing Your Audience
11.4 Organizing Abstracts
11.5 Avoiding Overly Technical Language
Chapter 12: Reports
12.1 Communicating Factual Information
12.2 Determining Your Report's Purpose
12.3 Components of a Formal Report
12.4 Developing Ideas
12.5 The Toulmin Model of Argument

12.6 Passive Voice

Chapter 13: Proposals
13.1 An Overview of Proposal Writing
13.2 Planning and Researching Proposals
13.3 Analyzing Your Audience
13.4 Stating Your Themes Persuasively
13.5 Tips for International Communication

Chapter 14: Electronic Media: Online Help and Web site Design
14.1 Understanding the Differences Between Online and Print
14.2 Organizing Hypermedia
14.3 Designing for the Computer Screen
14.4 Editing Online Documents
14.5 Tips for International Communication

Chapter 15: Fliers, Brochures, and Newsletters
15.1 Understanding Marketing Writing
15.2 Brochures
15.3 Newsletters
15.4 Electronic Delivery: HTML or PDF?
15.5 Editing Marketing Documents

Chapter 16: Professional Presentations
16.1 Planning and Researching Presentations
16.2 Analyzing Your Audience
16.3 Designing Visual Aids
16.4 Delivery Techniques
16.5 Tips for International Communication

Chapter 17: Finding a Job
17.1 Types of Technical Jobs
17.2 Where to Find Leads
17.3 Choosing References
17.4 Web Resumes
17.5 Preparing Professional Portfolios
17.6 Following Up

13. Lab works

14. References

1. *"Technical Communication: A Reader-Centered Approach" 6th Edition* – Paul V. Anderson – Wadsworth Publishing, ISBN: 9781413017700
2. *"A Guide to Writing as an Engineer" 2nd Edition* – David F. Beer, David McMurrey – Wiley, ISBN: 978-0471430742

3. *"The Handbook of Technical Writing" 8th Edition* – Gerald J.Alred, Charles T. Brusaw, Walter E. Oliu – Beford/St. Martin's Press, ISBN: 978-0312352677
4. *"Technical English: Writing, Reading and Speaking" 8th Edition* – Nell Ann Pickett, Ann Appleton Laster, Katherine E. Staples – Longman, ISBN: 978-0321003522
5. *"Technical Communication: A Practical Approach" 6th Edition* – William S. Pfeiffer – Prentice Hall, ISBN: 978-0131198166
6. *"Technical Communication" 8th Edition* – Mike Markel – Beford/St. Martin's Press, ISBN: 978-0312455675

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ET1016 Introduction to Engineering

1. Course Title: **Introduction to Engineering**

2. Course ID: ET1016

3. Course Units: **3(2-1-0-6)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Second-year students in Advance Undergraduate Program

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

Upon completion of this course, students should have:

- An elementary knowledge of the disciplines in engineering, especially the undergraduate programs and extracurricular opportunities available
- A basic understanding of and experience in the steps and techniques of engineering design;
- Awareness of some ethical, social, political, and economic influences on and impacts of engineering design;
- Emerging skills in written and/or oral communication related to engineering design;
- Introductory skills in teamwork with peers;
- Preliminary development of the habits of mind that engineering study and practice require

8. Description

This course provides the incoming freshman with an overview of engineering based on a "hands-on" experience with a client-centered engineering design project, which includes: 1) a team-based design project, 2) a survey of engineering disciplines, and 3) an introduction to computer tools and lab techniques

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Class attendant: 10%
- Contribution to group: 20%
- Note book: 20%
- Group project: 50%

11. Course Materials

Lecture notes will be provided by instructors

12. Course Topics

INTRODUCTION TO ENGINEERING

Course Developer:

One of the key aspects of engineering education is the process by which students are prepared to practice design in industry. Until recently, design had often been taught only at the senior level after all of the basic science and engineering courses are taken, and the courses at this level were expected to integrate the material of the previous courses in the curriculum. There is increasing awareness that students may not see the need for the basic material in the early courses, and that when they reach the final design course they have deficiencies in their background knowledge and skills. One approach to ensuring a better appreciation of the material and retention of important information and the tools is to give students a design experience in the freshman year. Students can then develop a perspective on the need for science and engineering principles and learn the design methods employed in industry.

This course is designed so that second-year students, working in teams, solve a relevant problem for a local client, typically a community-service organization. The underlying goal of the course is to give students experience in engineering early on in their academic programs, and to allow them to make well-informed career choices. Although the specific problem or project varies from one lab section to another, the goals and methods are expected to remain the same.

This course provides second-year students with an overview of engineering based on a "hands-on" experience with a client-centered engineering design project, which includes an introduction to:

A. The design process and how to employ it;
B. Design resources available on campus;
C. Design skills necessary to the design process;
D. Design and communication as complementary activities; and
E. Engineering opportunities available in the college.

The students will engage in a cross-disciplinary design-oriented class, employ a project team format for cooperative student learning, find new information and resources as needed to keep teams progressing, build on previous learning as the course progresses, and learn issues related to business, law, and ethics throughout the course to provide a complete experience of how engineering operates.

During the course, students are acquired to attend 2 sessions, lecturing session and lab session. The schedule is as following

Week	**Large Group Session 1 (Monday/Tuesday)**	**Large Group Session 2 (Wednesday/Thursday)**	Lab Session **Team Goals for the Week**
(1)	***NO LECTURE***	**Introduction of Course & Staff** **Example Projects**	Introduce Project & Site Visit Plans Build Teams & Preview Schedule
(2)	**Design Process Overview**	***Design Process Overview***	**Conduct Site Visit** Identify Customer Specs Craft Problem Statement

(3)	**Project Management and Economics**	**Analysis P3 Sustainable Design Team (20 min)**	Brainstorm Ideas for Preliminary Design
(4)	**Engineering Career Services Engineering & Diversity**	**Attend Career Connections & Student Organizations Fair**	Evaluate Ideas for Preliminary Design Form Small Teams to Create Preliminary Design **Shop Training {Lecture 1, 1.5 hr}**
(5)	**Ethics in Engineering "From Natural Rubber to Synthetic Rubber - The Road from the Amazon to Auschwitz"**	**Engineering Ethics**	**Small Group Presentations in Lab** Re-Form Large Group Analyze Preliminary Designs
(6)	**Earthquake Engineering & Modeling**	**Fabrication & Testing**	Define and Brainstorm (large groups) **Shop Training {Lecture 2, 1.5 hr}**
(7)	**Preparing Posters**	**Poster Session**	Refine Preliminary Design Faculty Provide Mid-Semester Progress Report to Students (& Advisors)
(8)	**Department Fair**		Refine Preliminary Design **Design Review in Lab** **Non-lab Instructors Evaluate Designs**
(9)	**Environment & Sustainability**	**Failure Mode Effects Analysis (FMEA)**	Test/Evaluate Design **Design Review Outcome - Discussion**
(10)	**Health Care**	**Final Presentation Preparation**	Continue Final Design Fabrication Updates
(11)	**Nanotechnology**	**Health Care**	Continue Final Design Begin Draft of Final Presentation Draft Outline of Final Project Report
(12)	**Energy**	**Energy**	Near completion on final project Testing
(13)	**Certificate in International Eng. Study Abroad**	**NO LECTURE**	Edit Final Report & Presentation
(14)	**Transportation, Safety & Communication**	**Semester Wrap-Up**	Polish Final Documentation Deliver Project to Client Practice for Final Presentations
(15)	**Final Presentations**	**Final Presentations**	**Final Packet Due @ Presentation** **Final Project Report Due @ Presentation**

Some Examples Project Titles in Engineering

- Airplane Hangar
- Gas Getter
- Hart's Bedroom
- Nuclear Reactor
- Somatron Cart
- Transitional Housing

- Cat Quarentine
- Simulated Hose
- Aveo
- Brake
- Bug Vacuum
- Chicken Pen
- Cool Box
- Erosion Control
- Flexural Steel
- Four Points
- Hydrogen
- JDRF Walk to Cure Diabates
- Muffler
- Oxygen Mount
- Potato Pest Vacuum
- Rope in a Bag
- Walker 1
- Walker 2
- Wheel Walker
- Badger Bike
- Batch Rotator
- BEAST
- Corn Root
- Emulsifier
- Gravity Well
- Hockey Stick
- No Step 1
- No Step 2
- Paper Shredder
- Postal Code
- Steam Chamber
- Step Stool
- The Slammer
- Tractor Lift 1
- Tractor Lift 2
- Tractor Lift 3
- Bike Rack
- Biodiesel
- Corn Counter
- Ergonomic Weeder
- Hose Reel
- Hospital Shelving
- Manure Sample Collector
- Mower Guide
- Piano Mover

- Pigeon Prevention
- Reel Easy
- Shinners
- Snowflake
- Stow-Away
- Wheelchair Foot Pedal
- Wheelchair Garden
- Artemia Hatchery
- ATV-mounted Fertilizer Spreader 1
- ATV-mounted Fertilizer Spreader 2
- ATV-mounted Fertilizer Spreader 3
- Automatic Farm Gate 1
- Automatic Farm Gate 2
- Bus Tracker 1
- Bus Tracker 2
- Gas Sampler
- Hornet Nest Filtration
- Mini-Diluter
- Pedestrian Flag
- Plant and Insect Sample Grinding
- Rain Barrel
- Rain Fall Collection
- Rainwater Filtration
- Respite Camp Path
- Roof Frame Boom
- Scaffolding Rack
- Solar Water Still
- Accessibility Box
- Bike Storage
- Exito
- Fish Feeder
- Gel Tester
- Inner Ear Model
- Medical Exam Room
- Playground
- Scaffolding Storage
- See Press
- Silage Chopper
- Skid Steer Caddie
- Water Purification
- Wheelchair for Honduras
- Barnyard Drainage
- EGR Office
- Irrigation System
- Sound Proofing

- Depressurization System
- Sterilizing Cooker
- Hay Baler
- Cooking Stove
- School Bus Seat Belt

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ME2006 Statics

1. Course Title: **Statics**

2. Course ID: ME2006

3. Course Units: **3(2-1-0-6)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Students must bring analytical, mathematical skills to ME2006, including problem-solving skills in analytical geometry, the ability to integrate and differentiate, and use and familiarity of transcendental and trigonometry functions.

6. Requisites

- Prerequisites: - MI1026, PH1016
- Corequisites: -

7. Objectives and Expected Outcomes

It is the instructor's intention to provide students with a thorough treatment of static analysis of structures, including: development of writing skills, and several design experiences.

Students must have the ability to

- Analyze a structure for support reactions and internal forces.
- Idealize practical problems by mathematical models.
- Design simple structures and systems.
- Communicate effectively via written reports.

8. Description

Principles of mechanics, force systems, equilibrium, structures, distributed forces, moments of inertia of areas, and friction.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 20%
- 1st mid-term: 10%
- 2nd mid-term: 20%
- 3rd mid-term: 20%
- Final exam: 30%

11. Course Materials

- *"Vector Mechanics for Engineers – Statics"* 9th Ed - Ferdinand P. Beer, E. Russell Johnston, David Mazurek – McGraw-Hill, ISBN: 978-0077275563

12. Course Topics

STATICS

Course Developer:

Chapter 1 -Introduction

1.1.What Is Mechanics?
1.2.Fundamental Concepts and Principles
1.3.Systems of Units
1.4.Conversion from One System of Units to Another
1.5.Method of Problem Solution
1.6.Numerical Accuracy

Chapter 2 - Statics of Particles

2.1.Introduction
2.2.Force on a Particle: Resultant of Two Forces
2.3.Vectors
2.4.Addition of Vectors
2.5.Resultant of Several Concurrent Forces
2.6.Resolution of a Force into Components
2.7.Rectangular Components of a Force. Unit Vectors
2.8.Addition of Forces by Summing x and y Components
2.9.Equilibrium of a Particle
2.10.Newton's First Law of Motion
2.11.Problems Involving the Equilibrium of a Particle.Free-Body Diagrams
2.12.Rectangular Components of a Force in Space
2.13.Force Defined by Its Magnitude and Two Points on Its Line of Action
2.14.Addition of Concurrent Forces in Space
2.15.Equilibrium ofa Particle in Space

Chapter 3 - Rigid Bodies: Equivalent Systems of Forces

3.1.Introduction
3.2.External and Internal Forces
3.3.Principle of Transmissibility. Equivalent Forces
3.4.Vector Product of Two Vectors
3.5.Vector Products Expressed in Terms of Rectangular Components
3.6.Moment of a Force about a Point
3.7.Varignon's Theorem
3.8.Rectangular Components of the Moment of a Force
3.9.Scalar Product of Two Vectors
3.10.Mixed Triple Product of Three Vectors
3.11.Moment of a Force about a Given Axis
3.12.Moment of a Couple
3.13.Equivalent Couples
3.14.Addition of Couples
3.15.Couples Can Be Represented by Vectors
3.16.Resolution of a Given Force Into a Force at O and a Couple
3.17.Reduction of a System of Forces to One Force and One Couple
3.18.Equivalent Systems of Forces

3.19.Equipollent Systems of Vectors
3.20.Further Reduction of a System of Forces
3.21.Reduction of a System of Forces to a Wrench

Chapter 4 - Equilibrium of Rigid Bodies
4.1.Introduction
4.2.Free-Body Diagram
4.3.Reactions at Supports and Connections for a Two-Dimensional Structure
4.4.Equilibrium of a Rigid Body in Two Dimensions
4.5.Statically Indeterminate Reactions: Partial Constraints
4.6.Equilibrium of a Two-Force Body
4.7.Equilibrium of a Three-Force Body
4.8.Equilibrium of a Rigid Body in Three Dimensions
4.9.Reactions at Supports and Connections for a Three-Dimensional Structure

Chapter 5 - Distributed Forces: Centroids and Centers of Gravity
5.1.Introduction
5.2.Center of Gravity of a Two-Dimensional Body
5.3.Centroids of Areas and Lines
5.4.First Moments of Areas and Lines
5.5.Composite Plates and Wires
5.6.Determination of Centroids by Integration
5.7.Theorems of Pappus-Guldinus
5.8.Distributed Loads on Beams
5.9.Forces on Submerged Surfaces
5.10.Center of Gravity of a Three-Dimensional Body: Centroid of a Volume
5.11.Composite Bodies
5.12.Determination of Centroids of Volumes by Integration

Chapter 6 - Analysis of Structures
6.1.Introduction
6.2.Definition of a Truss
6.3.Simple Trusses
6.4.Analysis of Trusses by the Method of Joints
6.5.Joints under Special Loading Conditions
6.6.Space Trusses
6.7.Analysis of Trusses by the Method of Sections
6.8.Trusses Made of Several Simple Trusses
6.9.Structures Containing Multiforce Members
6.10.Analysis of a Frame
6.11.Frames Which Cease to Be Rigid When Detached from Their Supports
6.12.Machines

Chapter 7 - Forces in Beams and Cables
7.1.Introduction
7.2.Internal Forces in Members
7.3.Various Types of Loading and Support

7.4.Shear and Bending Moment in a Beam
7.5.Shear and Bending-Moment Diagrams
7.6.Relations among Load, Shear, and Bending Moment
7.7.Cables with Concentrated Loads
7.8.Cables with Distributed Loads
7.9.Parabolic Cable
7.10.Catenary

Chapter 8- Friction
8.1.Introduction
8.2.The Laws of Dry Friction. Coefficients of Friction
8.3.Angles of Friction
8.4.Problems Involving Dry Friction
8.5.Wedges
8.6.Square-Threaded Screws
8.7.Journal Bearings: Axle Friction
8.8.Thrust Bearings: Disk Friction
8.9.Wheel Friction: Rolling Resistance
8.10.Belt Friction

Chapter 9 - Distributed Forces: Moments of Inertia
9.1.Introduction
9.2.Second Moment, or Moment of Inertia, of an Area
9.3.Determination of the Moment of Inertia of an Area by Integration
9.4.Polar Moment of Inertia
9.5.Radius of Gyration of an Area
9.6.Parallel-Axis Theorem
9.7.Moments of Inertia of Composite Areas
9.8.Product of Inertia
9.9.Principal Axes and Principal Moments of Inertia
9.10.Mohr's Circle for Moments and Products of Inertia
9.11.Moment of Inertia of a Mass
9.12.Parallel-Axis Theorem
9.13.Moments of Inertia of Thin Plates
9.14.Determination of the Moment of Inertia of a Three-Dimensional Body by Integration
9.15.Moments of Inertia of Composite Bodies
9.16.Moment of Inertia of a Body with Respect to an Arbitrary Axis through O: Mass Products of Inertia
9.17.Ellipsoid of Inertia: Principal Axes of Inertia
9.18.Determination of the Principal Axes and Principal Moments of Inertia of a Body of Arbitrary Shape

13. Lab works

14. References

1. *"Vector Mechanics for Engineers – Statics"* 9th Ed - Ferdinand P. Beer, E. Russell Johnston, David Mazurek – McGraw-Hill, ISBN: 978-0077275563
2. *"Engineering Mechanics - Statics"* 10th Ed - Russell C. Hibbeler - Prentice Hall, ISBN: 978-0131411678
3. *"Engineering Mechanics – Statics"* 6th Ed - J. L. Meriam, L. G. Kraige – Wiley, ISBN: 978-0471739326
4. *"Statics: Analysis and Design of Systems in Equilibrium"* - Sheri D. Sheppard, Benson H. Tongue – Wiley, ISBN: 978-0471947219
5. *"Engineering Mechanics – Statics"* 5th Ed – A. Bedford, Wallace L. Fowler – Prentice Hall, ISBN: 978-0136129158
6. *"Engineering Statics"* 2nd Ed - Arthur Stanley Hall, Frederick Ernest Archer, R. I. Gilbert - UNSW Press, ISBN: 978-0868404257

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ME3026 Dynamics

1. Course Title: **Dynamics**

2. Course ID: ME3026

3. Course Units: **3(2-1-0-6)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: As with ME2006-Statics, students need to bring strong analytical skills to ME3026, including knowledge of analytic geometry and differential and integral calculus.

6. Requisites

- Prerequisites: - MI1026, ME2006
- Corequisites: -

7. Objectives and Expected Outcomes

This course introduces engineering students to dynamics of particles and rigid bodies. Methods (kinematic relationships, Newton's laws, conservation of energy, momentum, and angular momentum) for analysing the motion of particles and bodies are learned. Students have an opportunity to apply dynamics principles to engineering design through two design projects.

Students must have the ability to

- Determine the kinematic relationships between position, velocity, and acceleration for two-dimensional motion of systems of particles and rigid bodies.
- Apply Newton's equation in two dimensions to calculate the motion due to applied forces or to calculate the forces resulting from a specified motion.
- Analyse the two dimensional motion of particles and rigid bodies using conservation laws for energy, momentum, and angular momentum.
- Apply dynamics concepts to the design of simple machines and structures to accomplish a specified task.
- Communicate effectively via written design reports.

8. Description

Kinematics, force-mass-acceleration relations, work and energy, impulse and momentum, moments of inertia and mass

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 20%
- 1st mid-term: 10%
- 2nd mid-term: 20%
- 3rd mid-term: 20%
- Final exam: 30%

11. Course Materials

- *"Engineering Mechanics: Dynamics"* 11st Ed – Rusell C. Hibbeler – Prentice Hall, ISBN: 978-0132038126

12. Course Topics

DYNAMICS

Course Developer:

Part I – KINEMATICS OF A PARTICLE

Chapter 1. Motion

1.1. Introduction
1.2.Rectilinear Kinematics: Continuous Motion
1.3.Rectilinear Kinematics: Erratic Motion
1.4.General Curvilinear Motion
1.5. Curvilinear Motion: Rectangular Components
1.6. Motion of a Projectile
1.7. Curvilinear Motion: Normal and Tangential Components
1.8. Curvilinear Motion: Cylindrical Components
1.9. Absolute Dependent Motion Analysis of Two Particles
1.10. Relative-Motion Analysis of Two Particles Using Translating Axes

Chapter 2. Force and Acceleration

2.1.Newton's Laws of Motion
2.2.The Equation of Motion
2.3.Equation of Motion for a System of Particles
2.4.Equation of Motion:Rectangular Coordinates
2.5.Equation of Motion:Normal and Tangential Coordinates
2.6.Equation of Motion:Cyclindrical Coordinates
2.7.Central-Force Motion and Space Mechanics

Chapter 3. Work and Energy

3.1.The Work of a Force
3.2.Principle of Work and Energy
3.3.Principle of Work and Energy for a System of Particles
3.4.Power and Efficiency
3.5.Conservative Forces and Potential Energy
3.6.Instantaneous Center of Zero
3.7.Relative-Motion Analyis: Acceleration
3.8.Relative-Motion Analyis Using Rotating Axes

Chapter 4. Impulse and Momentum

4.1.Principle of Linear Impulse and Momentum
4.2.Principle of Linear Impulse and Momentum for a System of Particles
4.3.Conversation of Linear Momentum for a System of Particles
4.4.Impact
4.5.Angular Momentum
4.6.Relation Between Moment of a Force and Angular Momentum
4.7.Angular Impulse and Momentum Principles
4.8.Steady Fluid Streams
4.9.Propulsion with Variable Mass

Part II – PLANAR KINEMATICS OF A RIGID BODY

Chapter 5. Rigid Body Motion

5.1.Rigid Body Motion
5.2.Translation
5.3.Rotation About a Fixed Axis
5.4.Absolute General Plane Motion Analysis
5.5.Relative-Motion Analysis: Velocity
5.6.Instantaneous Center of Zero Velocity
5.7.Relative-Motion Analysis Using Rotating Axes

Chapter 6. Force and Acceleration

6.1.Moment of Inertia
6.2.Planar Kinetic Equations of Motion
6.3.Equations of Motion: Translation
6.4.Equations of Motion: Rotation About a Fixed Axes
6.5.Equations of Motion: General Plane Motion

Chapter 7. Work and Energy

7.1.Kinetic Energy
7.2.The Work of a Force
7.3.The Work of a Couple
7.4.Principle of Work and Energy
7.5.Conservation of Energy

Chapter 8. Impulse and Momentum

8.1.Linear and Angular Momentum
8.2.Principle of Impulse and Momentum
8.3.Conservation of Momentum
8.4.Eccentric Impact

13. Lab works

14. References

1. *"Engineering Mechanics: Dynamics"* 11st Ed – Rusell C. Hibbeler – Prentice Hall, ISBN: 978-0132038126
2. *"Engineering Mechanics: Dynamics"* 6th Ed - J. L. Meriam, L. G. Kraige – John Wiley, ISBN: 978-0471739319
3. "*Engineering Mechanics-Statics and Dynamics Principles*" 3rd Ed - Anthony Bedford – Prentice Hall, ISBN: 978-0130082091
4. *"Engineering Applications of Dynamics"* - Dean C. Karnopp, Donald L. Margolis – Wiley, ISBN: 978-0470112663
5. *"Dynamics for Engineers"* - Soumitro Banerjee – Wiley, ISBN: 978-0470868447

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CH3206 Organic Chemistry

1. Course Title: **Organic Chemistry**

2. Course ID: CH3206

3. Course Units: **3(2-1-0-6)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Fourth-semester students in Undergraduate Advanced Programs.

6. Requisites

- Prerequisites: - CH1016
- Corequisites: -

7. Objectives and Expected Outcomes

For those students who expect to take only 1 semester organic chemistry. Student will be provided fundamental knowledge about structure, bonding, axids-bases, reaction mechanism, functional groups...of several simple organic compounds.

8. Description

Chemical compounds and bonding. Acids and bases. Thermodynamics. Reaction mechanism. Reduction and oxidation. Stereochemistry. Functional groups.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 20%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- 3rd mid-term: 20%
- Final exam: 20%

11. Course Materials

- "Organic Chemistry" 8th Ed - T. W. Graham Solomons, Craig B. Fryhle – Wiley, ISBN: 978-0471417996

12. Course Topics

ORGANIC CHEMISTRY

Course Developer:

Chapter 1. Carbon Compounds and Chemical Bonds.

1.1 Introduction
1.2 The Development of Organic Chemistry as a Science
1.3 The Structural Theory of Organic Chemistry
1.4 Chemical Bonds: The Octet Rule
1.5 Writing Lewis Structures
1.6 Exceptions to the Octet Rule
1.7 Formal Charge
1.8 Resonance
1.9 Quantum Mechanics
1.10 Atomic Orbitals
1.11 Molecular Orbitals
1.12 The Structure of Methane and Ethane: sp^3 Hybridization
1.13 The Structure of Ethene (Ethylene): sp^2 Hybridization
1.14 The Structure of Ethyne (Acetylene): *sp* Hybridization
1.15 A Summary of Important Concepts that Come from Quantum Mechanics
1.16 Molecular Geometry: The Valence Shell Electron-Pair Repulsion (VSEPR) Model
1.17 Representation of Structural Formulas

Chapter 2. Representative Carbon Compounds: Functional Groups, Intermolecular Forces, and Infrared (IR) Spectroscopy

2.1 Carbon-Carbon Covalent Bonds
2.2 Hydrocarbons: Representative Alkanes, Alkenes, Alkynes, and Aromatic Compounds
2.3 Polar Covalent Bonds
2.4 Polar and Nonpolar Molecules
2.5 Functional Groups
2.6 Alkyl Halides or Haloalkanes
2.7 Alcohols
2.8 Ethers
2.9 Amines
2.10 Aldehydes and Ketones
2.11 Carboxylic Acids, Amides, and Esters
2.12 Nitriles
2.13 Summary of Important Families of Organic Compounds
2.14 Physical Properties and Molecular Structure
2.15 Summary of Attractive Electric Forces
2.16 Infrared Spectroscopy: An Instrumental Method for Detecting Functional Groups

Chapter 3. An Introduction to Organic Reactions: Acids and Bases

3.1 Reactions and Their Mechanisms
3.2 Acid-Base Reactions
3.3 Heterolysis of Bonds to Carbon: Carbocations and Carbanions
3.4 Use of Curved Arrows in Illustrating Reactions

3.5 The Strength of Acids and Bases: K_a and pK_a
3.6 Predicting the Outcome of Acid-Base Reactions
3.7 The Relationship Between Structure and Acidity
3.8 Energy Changes
3.9 The Relationship Between the Equilibrium Constant and the Standard Free-Energy Change, ΔG^o
3.10 The Acidity of Carboxylic Acids
3.11 The Effect of the Solvent on Acidity
3.12 Organic Compounds as Bases
3.13 A Mechanism for an Organic Reaction
3.14 Acids and Bases in Nonaqueous Solutions
3.15 Acid-Base Reactions and the Synthesis of Deuterium- and Tritium-Labelled Compounds

Chapter 4. Alkanes: Nomenclature, Conformational Analysis, and an Introduction to Synthesis
4.1 Introduction to Alkanes and Cycloalkanes
4.2 Shapes of Alkanes
4.3 IUPAC Nomenclature of Alkanes, Alkyl Halides, amd Alcohols
4.4 Nomenclature of Cycloalkanes
4.5 Nomenclature of Alkenes and Cycloalkenes
4.6 Nomenclature of Alkynes
4.7 Physical Properties of Alkanes and Cycloalkanes
4.8 Sigma Bonds and Bond Rotation
4.9 Conformational Analysis of Butane
4.10 The Relative Stabilities of Cycloalkanes: Ring Strain
4.11 The Origin of Ring Strain in Cyclopropane and Cyclobutane: Angle Strain and Torsional Strain
4.12 Conformations of Cyclohexane
4.13 Substituted Cyclohexanes: Axial and Equatorial Hydrogen Atoms
4.14 Disubstituted Cycloalkanes: Cis-Trans Isomerism
4.15 Bicyclic and Polycyclic Ankanes
4.16 Chemical Reactions of Alkanes
4.17 Synthesis of Alkanes and Cycloalkanes
4.18 Some General Principles of Structure and Reactivity: A Look Toward Synthesis
4.19 An Introduction to Organic Synthesis

Chapter 5. Stereochemistry: Chiral Molecules
5.1 The Biological Significance of Chirality
5.2 Isomerism: Constitutional Isomers and Stereoisomers
5.3 Enantiomers and Chiral Molecules
5.4 More about the Biological Importance of Chirality
5.5 Historical Origin of Stereochemistry
5.6 Tests for Chirality: Planes of Symmetry
5.7 Nomenclature of Enantiomers: The (R-S) System
5.8 Properties of Enantiomers: Optical Activity
5.9 The Origin of Optical Activity

5.10 The Synthesis of Chiral Molecules
5.11 Chiral Drugs
5.12 Molecules with More Than One Stereocenter
5.13 Fischer Projection Formulas
5.14 Stereoisomerism of Cyclic Compounds
5.15 Relating Configurations Through Reactions in Which No Bonds to the Stereocenter Are Broken
5.16 Separation of Enantiomers: Resolution
5.17 Compounds with Stereogenic Centers Other than Carbon
5.18 Chiral Molecules that Do Not Posssess a Tetrahedral Atom with Four Different Groups

Chapter 6. Ionic Reactions—Nucleophilic Substitution and Elimination Reactions of Alkyl Halides
6.1 Introduction
6.2 Physical Properties of Alkyl Halides
6.3 Nucleophilic Substitution Reactions
6.4 Nucleophiles
6.5 Leaving Groups
6.6 Kinetics of a Nucleophilic Substitution Reaction: An S_N2 Reaction
6.7 A Mechanism for the S_N2 Reaction
6.8 Transitiion State Theory: Free-Energy Diagrams
6.9 The Stereochemistry of S_N2 Reactions
6.10 The Reaction of *tert*-Butyl Chloride with Hydroxide Ion: An S_N1 Reaction
6.11 A Mechanism for the S_N1 Reaction
6.12 Carbocations
6.13 The Stereochemistry of S_N1 Reactions
6.14 Factors Affecting the Rates of S_N1 and S_N2 Reactions
6.15 Organic Synthesis: Functional Group Transformations Using S_N2 Reactions
6.16 Elimination Recations of Alkyl Halides
6.17 The E2 Reaction
6.18 The E1 Reaction
6.19 Substitution versus Elimination
6.20 Overall Summary

Chapter 7. Alkenes and Alkynes I: Properties and Synthesis, Elimination Reactions of Alkyl Halides
7.3 Relative Stabilities of Alkenes
7.4 Cycloakenes
7.5 Synthesis of Alkenes via Elimination Reactions
7.6 Dehydrohalogenation of Alkyl Halides
7.7 Dehydration of Alcohols
7.8 Carbocation Stability and the Occurrence of Molecular Rearrangements
7.11 The Acidity of Terminal Alkynes
7.12 Replacement of the Acetylenic Hydrogen Atom of Terminal Alkynes
7.13 Hydrogenation of Alkenes
7.14 Hydrogenation: The Function of the Catalyst

7.15 Hydrogenation of Alkynes
7.16 Molecular Formulas of Hydrocarbons: The Index of Hydrogen Deficiency

Chapter 8. Alkenes and Alkynes II: Addition Reactions
8.1 Introduction: Additions to Alkenes
8.2 Addition of Hydrogen Halides to Alkenes: Markovnikov's Rule
8.3 Stereochemistry of the Ionic Addition to an Alkene
8.4 Addition of Sulfuric Acid to Alkenes
8.5 Addition of Water to Alkenes: Acid-Catalyzed Hydration
8.6 Addition of Bromine and Chlorine to Alkenes
8.7 Stereochemistry of the Addition of Halogens to Alkenes
8.10 Oxidation of Alkenes: Syn Hydroxylation
8.11 Oxidative Cleavage of Alkenes
8.14 Oxidative Cleavage of Alkynes
8.15 Synthetic Strategies Revisited

Chapter 9. Radical Reactions
9.1. Principles of Homeostasis of Internal Fluids
9.2. A Survey of Excretory Organs
9.3. Structure and Function of the Mammalian Kidney
9.4. Impact on Public Health

Chapter 10. Alcohols and Ethers
10.1. The Evolution and Development of Nervous Systems
10.2. Structure and Function of the Human Nervous System
10.3. Cellular Components of Nervous Systems
10.4. Electrical Properties of Neurons
10.5. Communication Between Neurons
10.6. Impact on Public Health

Chapter 11. Alcohols from Carbonyl Compounds. Oxidation-Reduction and Organometallic Compounds
11.1. Mechanisms of Hormone Action and Control
11.2. Links Between the Endocrine and Nervous Systems
11.3. Control of Metabolism and Energy Balance by Hormones
11.4. Hormonal Control of Reproduction

Chapter 12. Conjugated Unsaturated Systems
12.1. Types of Pathogens
12.2. Nonspecific (Innate) Immunity
12.3. Specific (Acquired) Immunity
12.4. Impact on Public Health

13. Lab works

14. References

1. "Organic Chemistry" 8th Ed - T. W. Graham Solomons, Craig B. Fryhle – Wiley, ISBN: 978-0471417996
2. “Fundamentals of Organic Chemistry” 5th Ed - John E. McMurry – Brook Cole, ISBN: 978-0534395735
3. “Organic Chemistry: Structure and Function” 5th Ed - K. Peter C. Vollhardt, Neil E. Schore - W. H. Freeman, ISBN: 978-0716799498
4. “Organic Chemistry” 2nd Ed - Joseph M. Hornback, Brook Cole, ISBN: 978-0534389512
5. “Organic Chemistry” 5th Ed - Leroy G. Wade – Prentice Hall, ISBN: 978-0132399883

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CH3306 Analytical Chemistry

1. Course Title: **Analytical Chemistry**

2. Course ID: CH3306

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: First-year students in Undergraduate Advanced Programs or other first-year students having good English skills.

6. Requisites

- Prerequisites: - CH1016
- Corequisites: -

7. Objectives and Expected Outcomes

Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences

8. Description

Fundamentals of chemical measurement in chemistry, biology, engineering, geology, and the medical sciences. Topics include equilibria of complex systems, spectroscopy, electrochemistry, separations, and quantitative laboratory technique. Lecture, lab, and discussion.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab work:

10. Assessment

- Homework: 20%
- Lab work: 20%
- 1st mid-term: 15%
- 2nd mid-term: 15%
- Final exam: 30%

11. Course Materials

- *"Quantitative Chemical Analysis"* 6th Ed - Daniel C. Harris - W H Freeman & Co, ISBN: 978-0716770411

12. Course Topics

ANALYTICAL CHEMISTRY

Course Developer:

Chapter 1. Experimental Error

1.1. Significant Figure
1.2. Significant Figure in Arthimetic
1.3. Types of error
1.4. Propagation of Uncertainty from Random Error
1.5. Propagation of Uncertainty: Systematic Error

Chapter 2. Statistics

2.1. Gaussian Distribution
2.2. Confidence Intervals
2.3. Comparision of Means with Students *t*
2.4. Comparison of Standard Deviations with the *F* Test
2.5. *t* Test with a Spreadsheet
2.6. *Q* Test for Bad Data
2.7. The Method of Least Squares
2.8. Calibration Curves
2.9. A Spreasheet for Leastsquare

Chapter 3. Chemical Equilibrium

3.1. The Equilibrium Constant
3.2. Equilibrium and Thermodynamics
3.3. Solubility Product
3.4. Complex Formation
3.5. Proctic Acids and Bases
3.6. pH
3.7. Strengths of Acids and Bases
3.8. Solving Equilibrium Problems with a Concentration Table and a Spreadsheet

Chapter 4. Monoprotic Acid-Bases Equilibria

4.1. Strong Acids and Bases
4.2. Weak Acids and Bases
4.3. Weal-Acid Equilibria
4.4. Weal-Base Equilibria
4.5. Buffers

Chapter 5. Advanced Topics in Equilibrium

5.1. General Approach to Acid-Base Systems
5.2. Activity Coefficients
5.3. Dependence of Solubility on pH
5.4. Analyzing Acid-Base Titrations with Difference Plots

Chapter 6. Polyprotic Acid-Base Equilibria
6.1. Diprotic Acids and Bases
6.2. Diprotic Buffers
6.3. Polyprotic Acids and Bases
6.4. Which Is The Principal Species?
6.5. Fractional Composition Equations
6.6. Isoelectronic pH, Isoionic pH

Chapter 7. EDTA Titrations
7.1. Metal-Chelate Complexes
7.2. EDTA
7.3. EDTA Titration Curves
7.4. Do It with a Spreadsheet
7.5. Auxiliary Complexing Agents
7.6. Metal Ion Indicators
7.7. EDTA Titration Techniques

Chapter 8. Acid-Base Titrations
8.1. Titration of Strong Base with Strong Acid
8.4. Titration of Weak Acid With Strong Base
8.5. Titration of Weak Base With Strong Acid
8.6. Titrations in Diprotic Systems
8.7. Finding The End Point with a pH Electrode
8.8. Finding the End Point with indicators
8.9. Practical Notes
8.10. The Leveling Effect
8.11. Calculating Titration Curves with Spreadsheet

Chapter 9. Fundamentals of Electrochemistry
9.1. Basic Concepts
9.2. Galvanic Cells
9.3. Standard Potentials
9.4. Nernst Equation
9.5. E° and Equilibrium Constant
9.6. Cells As Chemical Probes
9.7. Biochemists Uses E°

Chapter 10. Electrodes and Potentiometry
10.1. Reference Electrodes
10.2. Indicator Electrodes
10.3. What is a Junction Potential?
10.4. How Ion Selective Electrodes Work
10.5. pH Measurement with a Glass Electrode
10.6. Ion Selective Electrodes
10.7. Solid-State Chemical Sensor

Chapter 11. Electroanalytical Techniques

11.1. Fundamentals of Electrolysis
11.2. Electrogravimetric Analysis
11.3. Coulometry
11.4. Amperometry
11.5. Voltammetry
11.6. Karl Fischer Titration of H_2O

Chapter 12. Atomic Spectroscopy

12.1. An Overview
12.2. Atomization: Flames, Furnaces, and Plasmas
12.3. How Temperature Affects Atomic Spectroscopy
12.4. Instrumentation
12.5. Interference
12.6. Inductively Coupled Plasma–Mass Spectrometry

Chapter 13. Spectrophotometers

13.1. Lamps And Lasers: Sources of Light
13.2. Monochromators
13.3. Detectors
13.4. Optical Sensors
13.5. Fourier Transform Infrared Spectrocopy

Chapter 14. Introduction to Analytical Separations

14.1. Solvent Extraction
14.2. What is Chromatography
14.3. A Plumbers View of Chromatography
14.4. Efficiency of Separation
14.5. Why Bands Spread

Chapter 15. Chromatographic Methods and Capillary Electrophoresis

15.1. Ion-Exchange Chromatoraphy
15.2. Ion Chromatoraphy
15.3. Molecular Exclusion Chromatoraphy
15.4. Affinity Chromatoraphy
15.5. Principles of Capillary Electrophoresis
15.6. Conduting Capillary Electrophoresis
16.7. Lap on Chip

Chapter 16. Gas Chromatography

16.1 The separation Process in Gas Chromatography
16.2. Sample injection
16.3. Detectors
16.4. Sample Preparation
16.5. Method Development in Gas chromatography

Chapter 17. High performance liquid chromatography

17.1. The chromatographic process
17.2. Injection and detection in HPLC
17.3. Method Development for Reversed-Phase Seperations
17.4. Gradient Separations

13. Lab works

The laboratory emphasizes quantitative skills in gravimetric, volumetric, and instrumental chemical analysis. The laboratory covers a gravimetric calcium analysis, acid/base, chelation, and redox titrations, trace analysis using absorption spectroscopy, potentiometric measurements with redox and ion selective electrodes, gas and liquid chromatographic analyses, and practical analysis problems

14. References

1. *"Quantitative Chemical Analysis"* 6th Ed - Daniel C. Harris - W H Freeman & Co, ISBN: 978-0716770411
2. "Exploring Chemical Analysis" 3rd Ed – Daniel C. Harris – W. H. Freeman, ISBN: 978-0716705710
3. *"Analytical Chemistry"* 6th Ed - Gary D. Christian – Wiley, ISBN: 978-0471214724
4. *"Analytical Chemistry: A Modern Approach to Analytical Science"* 2nd Ed - Robert Kellner, Jean-Michel Mermet, Matthias Otto, Miguel Valcárcel, H. Michael Widmer – Wiley, ISBN: 978-3527305902
5. *"Fundamentals of Analytical Chemistry"* 8th Ed - Douglas A. Skoog, Donald M. West, F. James Holler, Stanley R. Crouch – Brook Cole, ISBN: 978-0030355233
6. *"Dean's Analytical Chemistry Handbook"* 2rd Ed - Pradyot Patnaik - McGraw-Hill, ISBN: 978-0071410601

Chairman of the Scientific and Education Council

ET3006 Computer Programming

1. Course Title: **Computer Programming**

2. Course ID: ET3006

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Problem solving skills such as those acquired in a statistics, logic, or advanced high school algebra course

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

- This course will develop the student's ability to solve problems using object-oriented programming language.

8. Description

Instruction and experience in the use of an object-oriented programming language. Program design; development of good programming style; preparation for other Computer Science courses.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Lab: 10%
- Assignments 30%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- Final exam: 20%

11. Course Materials

- *"Java Concepts" 5th Edition* – Cay S. Horstmann – John Wiley & Sons, ISBN: 978-0470105559

12. Course Topics

COMPUTER PROGRAMMING

Course Developer:

Chapter 1. Introduction

1.1. What Is Programming?
1.2. The Anatomy of a Computer
1.3. Translating Human-Readable Programs to Machine Code
1.4. The Java Programming Language
1.5. Becoming Familiar with Your Computer
1.6. Compiling a Simple Program
1.7. Errors
1.8. The Compilation Process

Chapter 2. Using Objects

2.1. Types and Variables
2.2. The Assignment Operator
2.3. Objects, Classes, and Methods
2.4. Method Parameters and Return Values
2.5. Number Types
2.6. Constructing Objects
2.7. Accessor and Mutator Methods
2.8. Implementing a Test Program
2.9. The API Documentation
2.10. Object References

Chapter 3. Implementing Classes

3.1. Levels of Abstraction
3.2. Specifying the Public Interface of a Class
3.3. Commenting the Public Interface
3.4. Instance Fields
3.5. Implementing Constructors and Methods
3.6. Unit Testing
3.7. Categories of Variables
3.8. Implicit and Explicit Method Parameters

Chapter 4. Fundamental Data Types

4.1. Number Types
4.2. Constants
4.3. Assignment, Increment, and Decrement
4.4. Arithmetic Operations and Mathematical Functions
4.5. Calling Static Methods
4.6. Strings
4.7. Reading Input

Chapter 5. Decisions
5.1. The if Statement
5.2. Comparing Values
5.3. Multiple Alternatives
5.4. Using Boolean Expressions
5.5. Test Coverage

Chapter 6. Iteration
6.1. while Loops
6.2. for Loops
6.3. Nested Loops
6.4. Processing Sentinel Values
6.5. Random Numbers and Simulations
6.6. Using a Debugger
6.7. A Sample Debugging Session

Chapter 7. Arrays and Array Lists
7.1. Arrays
7.2. Array Lists
7.3. Wrappers and Auto-boxing
7.4. The Enhanced for Loop
7.5. Simple Array Algorithms
7.6. Two-Dimensional Arrays
7.7. Copying Arrays

Chapter 8. Designing Classes
8.1. Choosing Classes
8.2. Cohesion and Coupling
8.3. Accessors, Mutators, and Immutable Classes
8.4. Side Effects
8.5. Preconditions and Postconditions
8.6. Static Methods
8.7. Static Fields
8.8. Scope
8.9. Packages
8.10 The Software Life Cycle
8.11 Discovering Classes

Chapter 9. Interfaces and Polymorphism
9.1. Using Interfaces for Code Reuse
9.2. Converting Between Class and Interface Types
9.3. Polymorphism

Chapter 10. Inheritance
10.1. An Introduction to Inheritance

10.2. Inheritance Hierarchies
10.3. Inheriting Instance Fields and Methods
10.4. Subclass Construction
10.5. Converting Between Subclass and Superclass Types
10.6. Polymorphism
10.7. Access Control
10.8. Object: The Cosmic Superclass

Chapter 11. Input/Output and Exception Handling
11.1. Reading and Writing Text Files
11.2. Throwing Exceptions
11.3. Checked and Unchecked Exceptions
11.4. Catching Exceptions
11.5. The finally Clause
11.6. Designing Your Own Exception Types
11.7. Case Study: A Complete Example

13. Lab work

14 x 2-hour lab

14. References

1. *"Java Concepts" 5th Edition* – Cay S. Horstmann – John Wiley & Sons, ISBN: 978-0470105559
2. *"Introduction to Java Programming" 7th Edition* – Daniel Y. Liang – Prentice Hall, ISBN: 978-0136012672
3. *"Introduction to Programming with Java: A Problem Solving Approach"* – John Dean, Ray Dean – McGraw-Hill, ISBN: 978-0073047027
4. "*Java: Introduction to Problem Solving and Programming*" 5th Edition – Water Savitch, Frank M. Carrano – Prentice Hall, ISBN: 978-0136072256

Chairman of the Scientific and Education Council

ET3016 Signals and Systems

1. Course Title: **Signals and Systems**

2. Course ID: ET3016

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Calculus. First/second-order differential equations. Super-position. RLC circuits: time and frequency response characteristics

6. Requisites

- Prerequisites: - ET3036
- Corequisites: -

7. Objectives and Expected Outcomes

Upon completing the course, students are able to

- Determine whether a signal has the following properties: discrete time, continuous time, power, energy, periodic, aperiodic, even, odd
- Perform the following operations on signals, alone or in combination: amplitude scaling, addition, multiplication, differentiation, integration time scaling, reflection, time shifting
- Identify and use the following elementary signals: exponentials, sinusoids, complex exponentials, exponentially damped sinusoids step functions, impulses, sifting and time scaling properties of impulses
- Identify and manipulate series and parallel interconnections of systems
- Determine whether an input/output description for a system has the following properties: stability, memory, memoryless, causality, invertibility (simple cases), time invariance, linearity
- Evaluate the convolution sum and integral given an input and the impulse response
- Use the commutative, associative, and distributive properties of convolution
- Determine whether a system described by an impulse response has properties: memoryless, causal, stable
- Find the step and frequency responses of a system given the impulse response
- Characterize the natural response, forced response, and complete response for systems described by second order difference or differential equations
- Determine whether a system described by a difference or differential equation is stable
- Determine whether the DTFS, FS, DTFT, or FT representation is appropriate for a give signal
- Evaluate the DTFS, FS, DTFT, and FT representations of time signals using the defining equations
- Evaluate the time domain signal corresponding to DTFS, FS, DTFT, and FT representations using the defining equations
- Use partial fraction expansions to find the inverse DTFT and FT
- Use the tables of representations and properties to find the appropriate representation or time signal

- Use the frequency response to solve for the input, output, or impulse response of a system given the other two signals
- Determine the frequency response of systems described by differential and difference equations
- Use the FT or DTFT representation for periodic signals to analyze mixtures of periodic and aperiodic signals
- Determine the FT representation for a sampled signal
- Determine the conditions on the sampling rate or interval that guarantee a bandlimited signal can be uniquely reconstructed from its samples
- Identify the specifications of an anti-imaging filter for reconstructing continuous-time signals from samples
- Find the Laplace transform of a time signal using the defining equation
- Find the Laplace transform and inverse Laplace transform using the tables of transforms and properties
- Use the method of partial fractions to find inverse Laplace transforms
- Use the unilateral Laplace transform to solve second order differential equations. Identify the natural and forced response components of the solution.

8. Description

Time-domain response and convolution; frequency-domain response using Fourier series, Fourier transform, Laplace transform; discrete Fourier series and transform; sampling; z-transform; relationships between time and frequency descriptions of discrete and continuous signals and systems

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 10%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 30%

11. Course Materials

- *"Signals and Systems" 2nd Edition* –S. Haykin, B. Van Veen – John Wiley & Sons, ISBN: 978-0470105559

12. Course Topics

SIGNALS AND SYSTEMS

Course Developer:

Chapter 1. Introduction

1.1 Continuous and discrete-time signals
1.2 Operations on signals
1.3 Properties of signals
1.4 Elementary signals
1.5 Continuous- and discrete-time systems
1.6 Interconnections of systems
1.7 System Properties

Chapter 2. Time Domain Representations for Linear Time Invariant Systems

2.1 Convolution
2.2 Properties of convolution
2.3 Difference and differential equations - characterizing solutions

Chapter 3. Fourier Representations of Signals

3.1 Discrete time periodic signals - the discrete time Fourier series
3.2 Continuous time periodic signals - the Fourier series
3.3 Discrete time nonperiodic signals - the discrete time Fourier transform
3.4 Continuous time nonperiodic signals - the Fourier transform
3.5 Properties of Fourier representations

Chapter 4. Applications of Fourier Representations

4.1 Frequency response from time-domain system descriptions
4.2 Fourier transform representations for periodic signals
4.3 Convolution and modulation revisited - mixing periodic and nonperiodic signals
4.4 The Fourier transform representation for discrete-time signals
4.5 Sampling continuous-time signals
4.6 Reconstruction of continuous-time signals from samples

Chapter 5. The Laplace transform

5.1 Definition
5.2 Convergence
5.3 Properties
5.4 Inversion
5.5 Solving Differential Equations
5.6 Transform Analysis of Systems

13. Lab works

14. References

1. *"Signals and Systems" 2nd Edition* –S. Haykin, B. Van Veen – John Wiley & Sons, ISBN: 978-0470105559

2. *"Signals and Systems with Matlab Applications" 2nd Edition* – Steven T. Karris – Orchad Publication, ISBN: 097-09551183
3. *"Signals and Systems" 2nd Edition* – A.V. Oppenheim, A.S. Willsky, S.H. Nawab – Prentice Hall, ISBN: 978-0073047027

Chairman of the Scientific and Education Council

ET3036 Circuit Analysis

1. Course Title: **Circuit Analysis**

2. Course ID: ET3036

3. Course Units: **4(3-1-1-6)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic electromagnetics: charge and flux, SI units, properties of physical capacitors and inductors. Solution techniques for linear constant coefficient differential equations. Familiarity with basic matrix/vector operations suggested.

6. Requisites

- Prerequisites: - MI1026, PH1026
- Corequisites: -

7. Objectives and Expected Outcomes

- Students completing this course will master analysis of physical circuits through the use of Kirchhoff's laws and ideal circuit element models. Strong emphasis is placed on the formulation of nodal equations for linear resistive circuits as a foundation, but generalizations necessary for handling nonlinear elements are also highlighted.
- Consequences of linearity are emphasized through superposition and Thevenin/Norton equivalents. Transient analysis of second order circuits with unit step inputs and switched dc sources is emphasized to promote understanding of time-domain linear circuit response.
- For linear circuits excited with sinusoidal sources, phasor and frequency domain analysis techniques for determining steady state response are emphasized. Application of complex power calculations is also highlighted.
- Finally, students will master concepts of coupled inductors and transformers as an illustration of the general two-port concept.

8. Description

Kirchhoff's laws, resistive circuits, equivalent circuits using Thevenin-Norton theories, small signal analysis, dc operating point, first-order circuits, second-order circuits, SPICE and circuit simulation methods, sinusoidal steady state, phasors, poles and zeros of network functions, ideal transformed linear and non-linear two-port networks.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 20%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 30%

11. Course Materials

- *"Engineering Circuit Analysis" 7th Edition* – W. H. Hayt, J. E. Kemmerly, S. M. Durbin – McGraw-Hill, ISBN: 978-0072866117

12. Course Topics

CIRCUIT ANALYSIS

Course Developer:

Chapter 1: Circuit Analysis and Electrical Engineering

1.1 Introduction
1.2 Overview of the Text
1.3 Relationship of Circuit Analysis to Engineering
1.4 Analysis and Design
1.5 Computer-Aided Analysis
1.6 Successful Problem-Solving Strategies
1.7 Recommended Reading

Chapter 2: Basic Components and Electric Circuits

2.1 Introduction
2.2 Units and Scales
2.3 Charge, Current, Voltage, and Power
2.4 Voltage and Current Sources
2.5 Ohm's Law
2.6 Summary and Review
2.7 Exercises

Chapter 3: Voltage and Current Laws

3.1 Introduction
3.2 Nodes, Paths, Loops, and Branches
3.3 Kirchoff' s Current Law
3.4 Kirchoff' s Voltage Law
3.5 The Single-Loop Circuit
3.6 The Single Node-Pair Circuit
3.7 Series and Parallel Connected Independent Sources
3.8 Resistors in Series and Parallel
3.9 Summary and Review
3.10 Exercises

Chapter 4: Basic Nodal and Mesh Analysis

4.1 Introduction
4.2 Nodal Analysis
4.3 The Supernode
4.4 Mesh Analysis
4.5 The Supermesh
4.6 Nodal vs. Mesh Analysis: A Comparison
4.7 Summary and Review
4.8 Exercises

Chapter 5: Useful Circuit Analysis Techniques

5.1 Introduction
5.2 Linearity and Superposition

5.3 Source Transformations
5.4 Thevenin and Norton Equivalent Circuits
5.6 Delta-Wye Conversion
5.7 Summary and Review
5.8 Exercises

Chapter 6: The Operational Amplifier
6.1 Introduction
6.2 Background
6.3 The Ideal Op Amp: A Cordial Introduction
6.4 Cascaded Stages
6.5 A More Detailed Model for the Op Amp
6.6 Practical Considerations
6.7 Summary and Review
6.8 Exercises

Chapter 7: Capacitors and Inductors
7.1 Introduction
7.2 The Capacitor
7.3 The Inductor
7.4 Inductance and Capacitance Combinations
7.5 Consequences of Linearity
7.6 Simple Op Amp Circuits with Capacitors
7.7 Summary and Review
7.8 Exercises

Chapter 8: Basic RL and RC Circuits
8.1 Introduction
8.2 The Source-Free RL Circuit
8.3 Properties of the Exponential Response
8.4 The Source-Free RC Circuit
8.5 A More General Perspective
8.6 The Unit-Step Function
8.7 Driven RL Circuits
8.8 Natural and Forced Response
8.9 Summary and Review
8.10 Exercises

Chapter 9: The RLC Circuit
9.1 Introduction
9.2 The Source-Free Parallel Circuit
9.3 The Overdamped Parallel RLC Circuit
9.4 Critical Damping
9.5 The Underdamped Parallel RLC Circuit
9.6 The Source-Free Series RLC Circuit

9.7 Summary and Review
9.8 Exercises

Chapter 10: Sinusoidal Steady-State Analysis
10.1 Introduction
10.2 Characteristics of Sinusoids
10.3 Forced Response to Sinusoidal Functions
10.4 The Complex Forcing Function
10.5 The Phasor
10.6 Phasor Relationships for R ,L ,and C
10.7 Impedance
10.8 Admittance
10.9 Nodal and Mesh Analysis
10.10 Superposition,Source Transformations,and Thévenin ’s Theorem
10.11 Summary and Review
10.12 Exercises

Chapter 11: AC Circuit Power Analysis
11.1 Introduction
11.2 Instantaneous Power
11.3 Average Power
11.4 Effective Values of Current and Voltage
11.5 Apparent Power and Power Factor
11.6 Summary and Review
11.7 Exercises

Chapter 12: Polyphase Circuits
12.1 Introduction
12.2 Polyphase Systems
12.3 Single-Phase Three-Wire Systems
12.4 Three-Phase Y-Y Connection
12.5 Summary and Review
12.6 Exercises

Chapter 13: Magnetically Coupled Circuits
13.1 Introduction
13.2 Mutual Inductance
13.3 Energy Considerations
13.4 The Linear Transformer
13.5 The Ideal Transformer
13.6 Summary and Review
13.7 Exercises

13. Lab works

6 x 3-hour lab

14. References

1. *"Engineering Circuit Analysis" 7th Edition* – W. H. Hayt, J. E. Kemmerly, S. M. Durbin – McGraw-Hill, ISBN: 978-0072866117
2. *"Basic Engineering Circuit Analysis" 8th Edition* – R. Mark Nelms – John Wiley & Sons , ISBN: 978-0471661580
3. *"Circuit Analysis: Theory and Practice" 4th Edition* – Allan H. Robbins, Wilhelm C. Miller – Cengage Learning, ISBN: 978-1418038618
4. *"Introductory Circuit Analysis" 11th Edition* – Robert L. Boylestad – Prentice Hall, ISBN: 978-0131730441
5. *"Electric Circuit Analysis" 3rd Edition* – David E. Johnson, John L. Hilburn, Johnny R. Johnson, Peter D. Scott – John Wiley & Sons, ISBN: 978-0471365716

Chairman of the Scientific and Education Council

ET3046 Electrodynamics I

1. Course Title: **Electrodynamics I**

2. Course ID: ET3046

3. Course Units: **3(2-1-0-6)**

- Lecture: 30 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic physics background relevant to electromagnetism: charge, force, SI system of units. Basic differential and integral vector calculus. Concurrent study of introductory lumped circuit analysis

6. Requisites

- Prerequisites: - MI1026, PH1026, ET3036
- Corequisites: -

7. Objectives and Expected Outcomes

This is the first of the two courses on beginning level electrodynamics. The purpose of the course is to provide sophomore/junior electrical engineering students with the fundamental methods to analyze and understand electromagnetic field problems that arise in various branches of engineering science.

8. Description

Vector analysis; potential theory; static and dynamic electric and magnetic fields; macroscopic theory of dielectric and magnetic materials; Maxwell's equations; boundary conditions

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 15%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 35%

11. Course Materials

- *"Field and Wave Electromagnetics"* 2nd Ed - David K. Cheng – Addison Wesley, ISBN: 978-0201128192

12. Course Topics

ELECTRODYNAMICS I

Course Developer:

Chapter1. The Electromagnetic Model.

1.1 Introduction.
1.2 The Electromagnetic Model.
1.3 Si Units and Universal Constants.
1.4 Review Questions.

Chapter2. Vector Analysis.

2.1 Introduction.
2.2 Vector Addition and Subtraction.
2.3 Products of Vectors.
2.4 Orthogonal Coordinate Systems.
2.5 Integrals Containing Vector Functions.
2.6 Gradient of a Scalar Field.
2.7 Divergence of a Vector Field.
2.8 Divergence Theorem.
2.9 Curl of a Vector Field.
2.10 Stoke's Theorem.
2.11 Two Null Identities.
2.12 Helmholtz's Theorem.

Chapter3. Static Electric Fields.

3.1 Introduction.
3.2 Fundamental Postulates of Electrostatics in Free Space.
3.3 Coulomb's Law.
3.4 Gauss's Law and Applications.
3.5 Electric Potential.
3.6 Conductors in Static Electric Field.
3.7 Dielectrics in Static Electric Field.
3.8 Electric Flux Density and Dielectric Constant.
3.9 Boundary Conditions for Electrostatic Fields.
3.10 Capacitances and Capacitors.
3.11 Electrostatic Energy and Forces.
3.12 Solution of Electrostatic Boundary-Value Problems.

Chapter4. Solution of Electrostatic Problems.

4.1 Introduction.
4.2 Poisson's and Laplaces' Equations.
4.3 Uniqueness of Electrostatic Functions.
4.4 Method of Images.

Chapter5. Steady Electric Currents.

5.1 Introduction.

5.2 Current Density and Ohm's Law.
5.3 ElectromotiveForce and Kirchoff's Voltage Law.
5.4 Equation of Continuity and Kirchoff's Current Law.
5.5 Power Dissipation and Joule's Law.
5.6 Boundary Conditions for Current Density.
5.7 Resistance Calculations.

Chapter6. Static Magnetic Fields.
6.1 Introduction.
6.2 Fundamental Postulates of Magnetostatics in Free Space.
6.3 Vector Magnetic Potential.
6.4 The Biot-Savart Law and Applications.
6.5 The Magnetic Dipole.
6.6 Magnetization and Equivalent Current Densities.
6.7 Magnetic Field Intensity and Relative Permeability.
6.8 Magnetic Circuits.
6.9 Behavior of Magnetic Materials.
6.10 Boundary Conditions for Magnetostatic Fields.
6.11 Inductances and Inductors.
6.12 Magnetic Energy.
6.13 Magnetic Forces and Torques.

13. Lab works

14. References

1. *"Field and Wave Electromagnetics"* 2nd Ed - David K. Cheng – Addison Wesley, ISBN: 978-0201128192
2. *"Electromagnetic Fields and Waves"* - Magdy F. Iskander - Waveland Pr Inc, ISBN: 978-1577661153
3. *"Electromagnetics"* 5th Ed - John D. Kraus, Daniel Fleisch – McGraw-Hill, ISBN: 978-0071164290
4. *"Engineering Electromagnetics"* 2nd Ed - Nathan Ida – Springer, ISBN: 978-0387201566
5. *"Engineering Electromagnetics"* 7th Ed - William H. Hayt, John A. Buck – McGraw-Hill, ISBN: 978-0072524952
6. *"Engineering Electromagnetics"* - Umran S. Inan, Aziz S. Inan – Prentice Hall, ISBN: 978-0805344233

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ET3048 Electrodynamics II

1. Course Title: **Electrodynamics II**

2. Course ID: ET3048

3. Course Units: **4(3-1-0-8)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic physics background relevant to electromagnetism: charge, force, SI system of units. Basic differential and integral vector calculus. Concurrent study of introductory lumped circuit analysis

6. Requisites

- Prerequisites: - MI1046, ET3046
- Corequisites: -

7. Objectives and Expected Outcomes

After finishing the course, students should have

- ability to carry out design-related analysis of a electromagnetic systems and device;
- development of skills in technical quantitative engineering analysis for systems containing components whose behavior is governed by electrodynamics; e.g. transmission lines, anteneas, waveguides, etc.
- impart knowledge of fabrication, assembly, and cost of manufacture issues for systems containing components whose behavior is governed by electrodynamics

8. Description

Static and dynamic electromagnetic fields; forces and work in electromechanical systems; magnetic circuits; plane wave propagation; reflection of plane waves; uniform transmission lines

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homework: 20%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- Final exam: 40%

11. Course Materials

- *"Field and Wave Electromagnetics"* 2nd Ed - David K. Cheng – Addison Wesley, ISBN: 978-0201128192

12. Course Topics

ELECTRODYNAMICS II

Course Developer:

Chapter 1. Static Magnetic Fields.

1.1 Introduction.
1.2 Fundamental Postulates of Magnetostatics in Free Space.
1.3 Vector Magnetic Potential.
1.4 The Biot-Savart Law and Applications.
1.5 The Magnetic Dipole.
1.6 Magnetization and Equivalent Current Densities.
1.7 Magnetic Field Intensity and Relative Permeability.
1.8 Magnetic Circuits.
1.9 Behavior of Magnetic Materials.
1.10 Boundary Conditions for Magnetostatic Fields.
1.11 Inductances and Inductors.
1.12 Magnetic Energy.
1.13 Magnetic Forces and Torques.

Chapter 2. Time-Varying Fields and Maxwell's Equations.

2.1 Introduction.
2.2 Faraday's Law of Electromagnetic Induction.
2.3 Maxwell's Equations.
2.4 Potential Functions.
2.5 Electromagnetic Boundary Conditions.
2.6 Wave Equations and their Solutions.
2.7 Time-Harmonic Fields.

Chapter 3. Plane Electromagnetic Waves.

3.1 Introduction.
3.2 Plane Waves in Lossless Media.
3.3 Plane Waves in Lossy Media.
3.4 Group Velocity.
3.5 Flow of Electromagentic Power and the Poynting Vector.
3.6 Normal Incidence of Plane Waves at a Plane Conducting Boundary.
3.7 Oblique Incidence of Plane Waves at a Plane Conducting Boundary.
3.8 Normal Incidence of Plane Waves at a Plane Dielectric Boundary.
3.9 Normal Incidence of Plane Waves at Multiple Dielectric Interfaces.
3.10 Oblique Incidence of Plane Waves at a Plane Dielectric Boundary.

Chapter 4. Theory and Application of Transmission Lines

4.1 Introduction.
4.2 Transverse Electromagnetic Wave Along a Parallel-Plate.
4.3 Transmission Line General Transmission-Line Equations.
4.4 Wave Characteristics on Finite Transmission Lines.
4.5 Transients on Transmission Lines.

Chapter 5. Waveguides and Cavity Resonators.

5.1 Introduction.
5.2 General Wave Behaviors Along Uniform Guiding Structures.
5.3 Parallel-Plate Waveguide.
5.4 Rectangular Waveguides.
5.5 Circular Waveguides.
5.6 Dielectric Waveguides.

13. Lab works

14. References

1. *"Field and Wave Electromagnetics" 2nd Ed* - David K. Cheng – Addison Wesley, ISBN: 978-0201128192
2. *"Electromagnetic Fields and Waves"* - Magdy F. Iskander - Waveland Pr Inc, ISBN: 978-1577661153
3. *"Electromagnetics" 5th Ed* - John D. Kraus, Daniel Fleisch – McGraw-Hill, ISBN: 978-0071164290
4. *"Engineering Electromagnetics" 2nd Ed* - Nathan Ida – Springer, ISBN: 978-0387201566
5. *"Engineering Electromagnetics" 7th Ed* - William H. Hayt, John A. Buck – McGraw-Hill, ISBN: 978-0072524952
6. *"Engineering Electromagnetics"* - Umran S. Inan, Aziz S. Inan – Prentice Hall, ISBN: 978-0805344233

Chairman of the Scientific and Education Council

ET3066 Digital System Fundamentals

1. Course Title: **Digital System Fundamentals**

2. Course ID: ET3066

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Construction of algorithms. Construction of flow charts. Familiarity with high level programming language and programming techniques

6. Requisites

- Prerequisites: - ET3006, ET3076
- Corequisites: -

7. Objectives and Expected Outcomes

After finishing the course, students should

- To be able to analyze and design digital logic systems by understanding formal foundations and selected design techniques.

8. Description

Logic components, Boolean algebra, combinational logic analysis and synthesis, synchronous and asynchronous sequential logic analysis and design, digital subsystems, computer organization and design.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 60%
- Project: 20%
- Final exam: 20%

11. Course Materials

- *"Logic and Computer Design Fundamentals" 3rd Edition* – M. Morris Mano, Charles R. Kime – Prentice Hall, ISBN: 978-0131405394

12. Course Topics

DIGITAL SYSTEM FUNDAMENTALS

Course Developer:

Chapter 1 DIGITAL COMPUTERS AND INFORMATION

1.1 Digital Computers
- 1.1.1 Information Representation
- 1.1.2 Computer Structure
- 1.1.3 More on Generic Computer

1.2 Number Systems
- 1.2.1 Binary Numbers
- 1.2.2 Octal and Hexadecimal Numbers
- 1.2.3 Number Ranges

1.3 Arithmetic Operations
- 1.3.1 Converstion from Decimal to Other Bases

1.4 Decimal Codes
- 1.4.1 BCD Addition
- 1.4.2 Parity Bit

1.5 Gray Codes

1.6 Alphanumeric Codes
- 1.6.1 ASCII Character Code

1.7 Chapter Summary

Chapter 2 COMBINATIONAL LOGIC CIRCUITS

2.1 Binary Logic and Gates
- 2.1.1 Binary Logic
- 2.1.2 Logic Gates

2.2 Boolean Algebra
- 2.2.1 Basic Identities of Boolean Algbra
- 2.2.2 Algebraic Manipulation
- 2.2.3 Complement of a Function

2.3 Standard Forms
- 2.3.1 Minterms and Maxterms
- 2.3.2 Sum of Products
- 2.3.3 Product of Sums

2.4 Two-Level Circuit Optimization
- 2.4.1 Cost Criteria
- 2.4.2 Two-Variable Map
- 2.4.3 Three-Variable Map
- 2.4.4 Four-Variable Map

2.5 Map Manipulation
- 2.5.1 Essential Prime Implicants
- 2.5.2 Nonessential Prime Implicants
- 2.5.3 Product-of-Sums Optimization
- 2.5.4 Don’t-Care Conditions

2.6 Multiple-Level Circuit Optimization
2.7 Other Gate Types
2.8 Exclusive-OR Operator and Gates
2.8.1 Odd Function
2.9 High-Impedance Outputs
2.10 Chapter Summary

Chapter 3 COMBINATIONAL LOGIC DESIGN
3.1 Design Concepts and Automation
3.1.1 Design Hierarchy
3.1.2 Top-Down Design
3.1.3 Computer-Aided Design
3.1.4 Hardware Description Languages
3.1.5 Logic Synthesis
3.2 The Design Space
3.2.1 Gate Properties
3.2.2 Levels of Integration
3.2.3 Circuit Technologies
3.2.4 Technology Parameters
3.2.5 Positive and Negative Logic
3.2.6 Design Trade-Offs
3.3 Design Procedure
3.4 Technology Mapping
3.4.1 Cell Specification
3.4.2 Libraries
3.4.3 Mapping Techniques
3.5 Verification
3.5.1 Manual Logic Analysis
3.5.2 Simulation
3.6 Programmable Implementation Technologies
3.6.1 Read-Only Memory
3.6.2 Programmable Logic Array
3.6.3 Programmable Array Logic Devices
3.7 Chapter Summary

Chapter 4 COMBINATIONAL FUNCTIONS AND CIRCUITS
4.1 Combinational Circuits
4.2 Rudimentary Logic Functions
4.2.1 Value-Fixing, Transfering and Inverting
4.2.2 Multiple-Bit Functions
4.2.3 Enabling
4.3 Decoding
4.3.1 Decoder Expansion
4.3.2 Decoder and Enabling Combinations
4.4 Encoding

4.4.1 Priority Encoder
4.4.2 Encoder Expansion
4.5 Selecting
4.5.1 Multiplexers
4.5.2 Multiplexer Expansion
4.5.3 Alternative Selection Implementations
4.6 Combinational Function Implementation
4.6.1 Using Decoders
4.6.2 Using Multiplexers
4.6.3 Using Read-Only Memories
4.6.4 Using Programmable Logic Arrays
4.6.5 Using Programmable Array Logic Devices
4.5.6 Using Lookup Tables
4.7 HDL Representation for Combinational Circuits-VHDL
4.8 HDL Representations for Combinational Circuits-Verilog
4.9 Chapter Summary

Chapter 5 ARITHMETIC FUNCTIONS AND CIRCUITS
5.1 Iterative Combinational Circuits
5.2 Binary Adders
5.2.1 Half Adder
5.2.2 Full Adder
5.2.3 Binary Ripple Carry Adder
5.2.4 Carry Lookahead Adder
5.3 Binary Subtraction
5.3.1 Complements
5.3.2 Subtraction with Complements
5.4 Binary Adder-Subtractors
5.4.1 Signed Binary Numbers
5.4.2 Signed Binary Addition and Subtraction
5.5 Binary Multiplication
5.6 Other Arithmetic Functions
5.6.1 Contraction
5.6.2 Incrementing
5.6.3 Decrementing
5.6.4 Multiplication by Constants
5.6.5 Division by Constants
5.6.6 Zero Fill and Extension
5.7 HDL Representations-VHDL
5.7.1 Behevioral Description
5.8 HDL Representations-Verilog
5.8.1 Behevioral Description
5.9 Chapter Summary

Chapter 6 SEQUENTIAL CIRCUITS

6.1 Sequential Circuit Definitions

6.2 Latches

- 6.2.1 SR and $\overline{S}\overline{R}$ Latches
- 6.2.2 D Latch

6.3 Flip-Flops

- 6.3.1 Master-Slave Flip-Flops
- 6.3.2 Edge-Triggered Flip-Flops
- 6.3.3 Standard Graphics Symbols
- 6.3.4 Direct Inputs
- 6.3.5 Flip-Flop Timing

6.4 Sequential Circuit Analysis

- 6.4.1 Input Equations
- 6.4.2 State Table
- 6.4.3 State Diagram
- 6.4.4 Sequencial Circuit Timing
- 6.4.5 Simulation

6.5 Sequential Circuit Design

- 6.5.1 Design Procedure
- 6.5.2 Finding State Diagrams and State Tables
- 6.5.3 State Assignment
- 6.5.4 Design with D Flip-Flops
- 6.5.5 Design with Unused States
- 6.5.6 Verification

6.6 Other Flip-Flop Types

- 6.6.1 JK and T Flip-Flops

6.7 HDL Representation for Sequential Circuits-VHDL

6.8 HDL Representation for Sequential Circuits-Verilog

6.9 Chapter Summary

Chapter 7 REGISTERS AND REGISTER TRANSFERS

7.1 Registers and Load Enable

- 7.1.1 Register with Parallel Load

7.2 Register Transfers

7.3 Register Transfer Operations

7.4 A Note for VHDL and Verilog Users Only

7.5 Microoperations

- 7.5.1 Arithmetic Microoperations
- 7.5.2 Logic Microoperations
- 7.5.3 Shift Microoperations

7.6 Micro operations on a Single Register

- 7.6.1 Muliplexer-Based Transfers
- 7.6.2 Shift Registers
- 7.6.3 Ripple Counters

7.7 Register Cell Design
7.8 Multiplexer and Bus-Based Transfers for Multiple Registers
7.8.1 Three-State Bus
7.9 Serial Transfer and Microoperations
7.9.1 Serial Addition
7.10 HDL Representation for Shift Registers and Counters -VHDL
7.11 HDL Representation for Shift Registers and Counters-Verilog
7.12 Chapter Summary

Chapter 8 SEQUENCING AND CONTROL
8.1 The Control Unit
8.2 Algorithmic State Machines
8.2.1 The ASM Chart
8.2.2 Timing Considerations
8.3 ASM Chart Examples
8.3 Binary Multiplier
8.4 Hardwired Control
8.4.1 Sequence Register and Decoder
8.4.2 One Flip-Flop per State
8.5 HDL Representation of the Binary Multiplier-VHDL
8.6 HDL Representation of the Binary Multiplier-Verilog
8.7 Microprogrammed Control
8.8 Chapter Summary

Chapter 9 MEMORY BASICS
9.1 Memory Definitions
9.2 Random-Access Memory
9.2.1 Write and Read Operations
9.2.2 Timing Waveforms
9.2.3 Properties of Memory
9.3 SRAM Integrated Circuits
9.3.1 Coincident Selection
9.4 Array of SRAM ICs
9.5 DRAM ICs
9.5.1 DRAM Cell
9.5.2 DRAM Bit Slide
9.6 DRAM Types
9.6.1 Synchronous DRAM (SDRAM)
9.6.2 Double Data Rate SDRAM (DDR SDRAM)
9.7 Arrays of Dynamic RAM ICs
9.8 Chapter Summary

Chapter 10 COMPUTER DESIGN BASICS
10.1 Introduction
10.2 Datapaths

10.3 The Arithmetic/Logic Unit
    10.3.1 Arithmetic Circuit
    10.3.2 Logic Circuit
    10.3.3 Arithmetic/Logic Unit
10.4 The Shifter
    10.4.1 Barrel Shifter
10.5 Datapath Representation
10.6 The Control Word
10.7 A Simple Computer Architecture
    10.7.1 Instruction Set Architecture
    10.7.2 Storage Resources
    10.7.3 Instruction Formats
    10.7.4 Instruction Specifications
10.8 Single-Cycle Hardwired Control
    10.8.1 Instruction Decoder
    10.8.2 Sample Instructions and Program
    10.8.3 Single-Cycle Computer Issues
10.9 Multiple-Cycle Hardwired Control
    10.9.1 Sequential Control Design
10.10 Chapter Summary

13. Lab works

7 x 3-hour lab

14. REFERENCES

1. *"Logic and Computer Design Fundamentals" 3nd Edition* – M. Morris Mano, Charles R. Kime – Prentice Hall, ISBN: 978-0131405394
2. *"Digital Design"* – Frank Vahid – John Wiley & Sons, ISBN: 978-0470044377
3. *"Digital Design: Principles and Practices Package" 4th Edition* – John F. Wakerly – Prentice Hall, ISBN: 978-0131733497
4. *"Introduction to Logic Design" 2nd Edition* – Alan B Marcovitz – McGraw-Hill, ISBN: 978-0072951769
5. *"Fundamentals of Logic Design" 5th Edition* – Charles H. Roth – Cengage-Engineering, ISBN: 978-0534378042

Chairman of the Scientific and Education Council

ET3076 Microelectronic Devices

1. Course Title: **Microelectronic Devices**

2. Course ID: ET3076

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Modern physics (simple band structure, statistical distribution functions). Electrostatics (Poisson equation). Analysis of passive circuits (Mainly R,C). Solution of first and second-order linear differential equations

6. Requisites

- Prerequisites: - PH1026, ET3026
- Corequisites: -

7. Objectives and Expected Outcomes

- The main goal is to provide the students with an understanding of the relation between physical structure and circuit behavior of semiconductor active devices.

- The emphasis is on simple models of the semiconductor, the discussion of the properties of potential barriers and field effect, with the MOSFET as the centerpiece of the course. Simple one-device circuits are used to introduce non-linear behavior, and make the connection to the device physics. The students will learn the relation between external circuit parameters (as used in SPICE) and the device internal structure.

- At the end of the course the students will know the basic mechanism of rectification, amplification and switching and their implementation with various types of semiconductor devices.

8. Description

Characteristics of semiconductors; study of physical mechanisms and circuit modeling of solid state electronic and photonic devices; principles of microelectronic processing and examples of integrated circuits.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 60%
- Project: 20%
- Final exam: 20%

11. Course Materials

- *"Semiconductor Device Fundamentals"* – Robert F. Pierret – Addison Wesley, ISBN: 978-0201543933

12. Course Topics

MICROELECTRONIC DEVICES

Course Developer:

Chapter 1. Semiconductors
1.1 A General Introduction.
1.2 General Material Properties
1.3 Crystal Structure
1.4 Crystal Growth

Chapter 2. Carrier Modeling
2.1 The Quantization Concept
2.2 Semiconductor Models
2.3 Carrier Properties
2.4 State and Carrier Distributions
2.5 Equilibrium Carrier Concentrations

Chapter 3. Carrier Action.
3.1 Drift
3.2 Diffusion
3.3 Recombination
3.4 Equations of State

Chapter 4. PN Junction Electrostatics
4.1 Preliminaries
4.2 Quantitative Electrostatic Relationships

Chapter 5. PN Junction Diode -- I-V Characteristics
5.1 The Ideal Diode Equation
5.2 Deviations from the Ideal
5.3 Special Considerations

Chapter 6. PN Junction Diode -- Small-Signal Admittance
6.1 Reverse-Bias Junction Capacitance
6.2 Forward-Bias Diffusion Admittance

Chapter 7. PN Junction Diode -- Transient Response
7.1 Turn-Off Transient
7.2 Turn-On Transient

Chapter 8. Field Effect Introduction -- the J-FET and MESFET
8.1 General Introduction
8.2 J-FET
8.3 MESFET.

Chapter 9. MOS Fundamentals
9.1 Ideal Structure Definition

9.2 Electrostatics -- Mostly Qualitative
9.3 Electrostatics -- Quantitative Formulation
9.4 Capacitance-Voltage Characteristics

Chapter 10. MOSFETs -- The Essentials
10.1 Qualitative Theory of Operation
10.2 Quantitative ID - VD Relationships
10.3 ac Response

Chapter 11. Nonideal MOS
11.1 Metal-Semiconductor Workfunction Difference
11.2 Oxide Charges
11.3 MOSFET Threshold Considerations

Chapter 12. Modern FET Structures
12.1 Small Dimension Effects

Chapter 13. BJT Fundamentals
13.1 Terminology
13.2 Fabrication
13.3 Electrostatics
13.4 Introductory Operational Considerations
13.5 Performance Parameters

Chapter 14. BJT Static Characteristics
14.1 Ideal Transistor Analysis
14.2 Deviations from the Ideal
14.3 Modern BJT Structures

Chapter 15. BJT Dynamic Response Modeling
15.1 Equivalent Circuits
15.2 Transient (Switching) Response

Chapter 16. PNPN Devices
16.1 Silicon Controlled Rectifier (SCR)
16.2 SCR Operational Theory
16.3 Practical Turn-on/Turn-off Considerations
16.4 Other PNPN Devices

13. Lab works

6 x 3-hour lab

14. REFERENCES

1. "*Semiconductor Device Fundamentals"* – Robert F. Pierret – Addison Wesley, ISBN: 978-0201543933

2. *"Solid State Electronic Devices" 6th Edition* – Ben Streetman, Sanjay Banerjee – Prentice Hall, ISBN: 978-0131497269
3. *"Modular Series on Solid State Devices" Vol IV* – Neudeck Gerold, R. F Pierret – Prentice Hall, ISBN: 978-0201122954
4. *"Modular Series on Solid State Devices" Vol IV* – Neudeck Gerold, R. F Pierret – Prentice Hall, ISBN: 978-0201122961
5. *"Modular Series on Solid State Devices" Vol III* – Neudeck Gerold, R. F Pierret – Prentice Hall, ISBN:978-0201122978
6. *"Modular Series on Solid State Devices" Vol IV* – Neudeck Gerold, R. F Pierret – Prentice Hall, ISBN: 978-0201122985
7. *"Fundamentals of Semiconductor Devices"* – Betty Lise Anderson, Richard L. Anderson – McGraw-Hill, ISBN: 978-0072369779

Chairman of the Scientific and Education Council

ET3086 Digital Signal Processing

1. Course Title: **Digital Signal Processing**

2. Course ID: ET3086

3. Course Units: **3(2-1-1-8)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Linear systems theory

6. Requisites

- Prerequisites: - ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

An introduction to the theory of discrete time systems and applications.

8. Description

Sampling continuous-time signals and reconstruction of continuous-time signals from samples; spectral analysis of signals using the discrete Fourier transform; the fast Fourier transform and fast convolution methods; z-transforms; finite and infinite impulse response filter design techniques; signal flow graphs and introduction to filter implementation

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 20%
- Lab: 20%
- Mid-term: 30%
- Final exam: 40%

11. Course Materials

- *"A Course in Digital Signal Processing" 7th Edition* – Boaz Porat– Wiley, ISBN: 978-0471149613

12. Course Topics

DIGITAL SIGNAL PROCESSING

Course Developer:

Chapter 1: Introduction

1.1 Signals
- 1.1.1 Continuous-Time Signals
- 1.1.2 Discrete-Time Signals

1.2 Systems
- 1.2.1 Continuous-Time Systems
- 1.2.2 Discrete-Time Systems
- 1.2.3 Linear Time-Invariant Systems

Chapter 2: Review of Frequency Domain Analysis

2.1 Specific Signals and Their Transforms
- 2.1.1 The delta function and the DC Function
- 2.1.2 Complex Exponentials and Sinusoids
- 2.1.3 The Rect and the Sinc
- 2.1.4 The Gaussian Function

2.2 Continuous-Time Periodic Signals

2.3 The Impulse Train

2.4 Discrete-Time Signals and Systems

2.5 Discrete-Time Periodic Signals

Chapter 3: Sampling and Reconstruction

3.1 Two Points of View on Sampling

3.2 The Sampling Theorem

3.3 The Three Cases of Sampling

3.4 Reconstruction

3.5 Decimation and Expansion

3.6 Transforms of Decimated and Expanded Sequences

3.7 Linear Filtering with Decimation and Expansion
- 3.7.1 Decimation
- 3.7.2 Expansion
- 3.7.3 Sampling-rate Conversion

Chapter 4: The Discrete Fourier Transform

4.1 Definition of the DFT and its Inverse

4.2 Matrix Interpretation of the DFT

4.3 Properties of the DFT

4.4 Zero Padding

4.6 Circular Convolution

4.7 Linear Convolution via Circular Convolution

4.8 The DFT of Sampled Periodic Signals

Chapter 5: Spectral Analysis
5.1 The Effect of Rectangular Windowing
5.2 Windowing
5.3 Common Windows
5.3.1 Rectangular Window
5.3.2 Bartlett Window
5.3.3 Hann Window
5.3.4 Hamming Window
5.3.5 Blackman Window
5.3.6 Kaiser Window
5.3.7 Dolph Window
5.3.8 MATLAB Implementation of Common Windows
5.4 Frequency Measurement
5.4.1 Frequency Measurement for a Single Complex Exponential
5.4.2 Frequency Measurement for Two Complex Exponentials
5.4.3 Frequency Measurement for Real Sinusoids
5.4.4 Practice of Frequency Measurement

Chapter 6: The Fast Fourier Transform
6.1 Operation Count
6.2 The Cooley-Tukey Decomposition
6.2.1 Derivation of the CT Decomposition
6.2.2 Recursive CT Decomposition and its Operation Count
6.2.3 Computation of the Twiddle Factors
6.2.4 Computation of the Inverse DFT
6.2.5 Time Decimation and Frequency Decimation
6.2.6 MATLAB Implementation of Cooley-Tukey FFT
6.3 Radix-2 FFT
6.3.1 The 2-Point DFT Butterfly
6.3.2 Time-decimated Radix-2 FFT
6.3.3 Frequency-decimated Radix-2 FFT
6.3.4 Signal Scaling in Radix-2 FFT
6.5 DFTs of Real Sequences
6.6 Linear Convolution by FFT

Chapter 7: Review of Z-Transforms and Difference Equations
7.1 The Z-Transform
7.2 Properties of the Z-Transform
7.3 Transfer Functions
7.4 Systems Described by Difference Equations
7.4.1 Difference Equations
7.4.2 Poles and Zeros
7.4.3 Partial Fraction Decomposition
7.4.4 Stability of Rational Transfer Functions
7.4.5 The Noise Gain of Rational Transfer Functions

7.5 Inversion of the Z-Transform
7.6 Frequency Responses of Rational Transfer Functions
7.7 The Unilateral Z-Transform

Chapter 8: Introduction to Digital Filters
8.1 Digital and Analog Filtering
8.2 Filter Specifications
8.2.1 Low-Pass Filter Specifications
8.2.2 High-Pass Filter Specifications
8.2.3 Band-Pass Filter Specifications
8.2.4 Band-Stop Filter Specifications
8.2.5 Multiband Filters
8.3 The Magnitude Response of Digital Filters
8.4 The Phase Response of Digital Filters
8.4.1 Phase Discontinuities
8.4.2 Continuous-Phase Representation
8.4.3 Linear Phase
8.4.4 Generalized Linear Phase
8.4.5 Restrictions on GLP Filters
8.4.6 Restrictions on Causal GLP Filters
8.4.7 Minimum-Phase Filters
8.4.8 All-Pass Filters
8.5 Digital Filter Design Considerations
8.5.1 IIR Filters
8.5.2 FIR Filters

Chapter 9: Finite Impulse Response Filters
9.1 Generalized Linear Phase Revisited
9.1.1 Type I Filters
9.1.2 Type II Filters
9.1.3 Type III Filters
9.1.4 Type IV Filters
9.1.5 Summary of Linear-Phase Filter Types
9.1.6 Zero Locations of Linear-Phase Filters
9.2 FIR Filter Design by Impulse Response Truncation
9.2.1 Definition of the IRT Method
9.2.2 Low-Pass, High-Pass, and Band-Pass Filters
9.2.3 Multi-Band Filters
9.2.4 Differentiators
9.2.5 Hilbert Transformers
9.2.6 Optimality of the IRT Method
9.2.7 Gibbs Phenomenon
9.3 FIR Filter Design Using Windows
9.4 FIR Filter Design Examples
9.5 Equiripple Design of FIR Filters

9.5.1 Mathematical Background
9.5.2 The Remez Exchange Algorithm
9.5.3 Equiripple FIR Design Examples

Chapter 10: Infinite Impulse Response Filters

10.1 Analog Filter Basics
10.2 Butterworth Filters
10.3 Chebyshev Filters
10.3.1 Chebyshev Filter of the First Kind
10.3.2 Chebyshev Filter of the Second Kind
10.4 Elliptic Filters
10.5 Summary of Properties and MATLAB Programs
10.6 Frequency Transformations
10.6.1 Low-Pass to Low-Pass Transformation
10.6.2 Low-Pass to High-Pass Transformation
10..6.3 Low-Pass to Band-Pass Transformation
10.6.4 Low-Pass to Band-Stop Transformation
10.6.5 MATLAB Implementation of Frequency Transformations
10.7 The Bilinear Transform
10.7.1 Definition and Properties of the Bilinear Transform
10.7.2 MATLAB Implementation of IIR Filter Design
10.7.3 IIR Filter Design Examples
10.8 The Phase Response of Digital IIR Filters

Chapter 11: Digital Filter Realization Considerations

11.1 Building Blocks of Digital Filters
11.2 Direct Realizations
11.3 Direct Realizations of FIR Filters
11.4 Parallel Realization
11.5 Cascade Realization
11.6 Pairing in Cascade Realization
11.7 A Coupled Cascade Realization
11.8 FFT-Based Realization of FIR Filters

13. Lab works

8 x 3-hour lab

14. References

1. *"A Course in Digital Signal Processing" 7th Edition* – Boaz Porat– Wiley, ISBN: 978-0471149613
2. *"Discrete-Time Signal Processing" 2nd Edition* – Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck – Prentice Hall, ISBN: 978-0137549207
3. *"Signals and Systems" 2nd Edition* – Simon Haykin, Barry Van Veen – Wiley, ISBN: 978-0471707899

4. "Computer-Based Exercises for Signal Processing Using MATLAB Ver.5" – James H. McClellan, C. Sidney Burrus, Alan V. Oppenheim, Thomas W. Parks, Schafer/ Schuessler – Prentice Hall, ISBN: 978-0137890095
5. *"Digital Signal Processing: Principles, Algorithms and Applications" 4th Edition* – John G. Proakis, Dimitris K Manolakis – Prentice Hall, ISBN: 978-0131873742

Chairman of the Scientific and Education Council

ET3096 Electronic Circuits I

1. Course Title: **Electronic Circuit I**

2. Course ID: ET3096

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Knowledge of terminal characteristics for standard linear circuit elements (R's, L's, C's, indepenentdent and dependent sources). Ability to solve circuits via nodal analysis. Basic knowledge of junction and channel behavior in semiconductor devices.

6. Requisites

- Prerequisites: - ET3026
- Corequisites: -

7. Objectives and Expected Outcomes

- Mastery of component level models of bipolar and field effect transistors.
- Ability to design differential and multi-stage transistor amplifier circuits.
- Knowledge of and design skills for non-ideal op-amp circuits.

8. Description

A first course in modeling, characterization, and application of semiconductor devices and integrated circuits. Development of appropriate models for circuit-level behavior of diodes, bi-polar and field effect transistors, and non-ideal op-amps. Application in analysis and design of linear amplifiers. Frequency domain characterizaion of transistor circuits.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 20%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 30%

11. Course Materials

- *"Microelectronic Circuits" 5th Edition* – Adel S. Sedra, Kenneth C. Smith – Oxford University Press, ISBN: 978-0195142518

12. Course Topics

ELECTRONIC CIRCUITS I

Course Developer:

Chapter 1: Introduction

1.1 Signals
1.2 Frequency Spectrum of Signals
1.3 Analog and Digital Signals
1.4 Amplifiers
    1.4.1 Signal Amplification
    1.4.2 Amplifier Circuit Symbol
    1.4.3 Voltage Gain
    1.4.4 Power Gain and Current Gain
    1.4.5 Expressing Gain in Decibels
    1.4.6 The Amplifier Power Supplies
    1.4.7 Amplifier Saturation
    1.4.8 Nonlinear Transfer Characteristics and Biasing
    1.4.9 Symbol Convention
1.5 Circuit Models for Amplifiers
    1.5.1 Voltage Amplifiers
    1.5.2 Cascaded Amplifiers
    1.5.3 Other Amplifier Types
    1.5.4 Relationships Between the Four Amplifier Models
1.6 Frequency Response of Amplifiers
    1.6.1 Measuring the Amplifier Frequency Response
    1.6.2 Amplifier Bandwidth
    1.6.3 Evaluating the Frequency Response of Amplifiers
    1.6.4 Single-Time-Constant Networks
    1.6.5 Classification of Amplifiers Based on Frequency Response

Chapter 2: Diodes

2.1 The Ideal Diode
    2.1.1 Current?Voltage Characteristic
    2.1.2 A Simple Application: The Rectifier
    2.1.3 Another Application: Diode Logic Gates
2.2 Terminal Characteristics of Junction Diodes
    2.2.1 The Forward-Bias Region
    2.2.2 The Reverse-Bias Region
    2.2.3 The Breakdown Region
2.3 Modeling the Diode Forward Characteristic
    2.3.1 The Exponential Model
    2.3.2 Graphical Analysis Using the Exponential Model
    2.3.3 Iterative Analysis Using the Exponential Model
    2.3.4 The Need for Rapid Analysis
    2.3.5 The Piecewise-Linear Model
    2.3.6 The Constant-Voltage-Drop Model

2.3.7 The Ideal-Diode Model
2.3.8 The Small-Signal Model
2.3.9 Use of the Diode Forward Drop in Voltage Regulation
2.3.10 Summary
2.4 Operation in the Reverse Breakdown Region--Zener Diodes
2.4.1 Specifying and Modeling the Zener Diode
2.4.2 Use of the Zener as a Shunt Regulator
2.4.3 Temperature Effects
2.4.4 A Final Remark
2.5 Rectifier Circuits
2.5.1 The Half-Wave Rectifier
2.5.2 The Full-Wave Rectifier
2.5.3 The Bridge Rectifier
2.5.4 The Rectifier with a Filter Capacitor--The Peak Rectifier
2.5.5 Precision Half-Wave Rectifier--The Super Diode
2.6 Limiting and Clamping Circuits
2.6.1 Limiter Circuits
2.6.2 The Clamped Capacitor or DC Restorer
2.6.3 The Voltage Doubler
2.7 Physical Operation of Diodes
2.7.1 Basic Semiconductor Concepts
2.7.2 The pn Junction Under Open-Circuit Conditions
2.7.3 The pn Junction Under Reverse-Bias Conditions
2.7.4 The pn Junction in the Breakdown Region
2.7.5 The pn Junction Under Forward-Bias Conditions
2.7.6 Summary
2.8 Special Diode Types
2.8.1 The Schottky-Barrier Diode (SBD)
2.8.2 Varactors
2.8.3 Photodiodes
2.8.4 Light-Emitting Diodes (LEDs)

Chapter 3: Bipolar Junction Transistors (BJTs)
3.1 Device Structure and Physical Operation
3.1.1 Simplified Structure and Modes of Operation
3.1.2 Operation of the npn Transistor in the Active Mode
3.1.3 Structure of Actual Transistors
3.1.4 The Ebers-Moll (EM) Model
3.1.5 Operation in the Saturation Mode
3.1.6 The pnp Transistor
3.2 Current-Voltage Characteristics
3.2.1 Circuit Symbols and Conventions
3.2.2 Graphical Representation of Transistor Characteristics
3.2.3 Dependence of iC on the Collector Voltage--The Early Effect
3.2.4 The Common-Emitter Characteristics

3.2.5 Transistor Breakdown
3.2.6 Summary
3.3 The BJT as an Amplifier and as a Switch
3.3.1 Large-Signal Operation--The Transfer Characteristic
3.3.2 Amplifier Gain
3.3.3 Graphical Analysis
3.3.4 Operation as a Switch
3.4 BJT Circuits at DC
3.5 Biasing in BJT Amplifier Circuits
3.5.1 The Classical Discrete-Circuit Bias Arrangement
3.5.2 A Two-Power-Supply Version of the Classical Bias Arrangement
3.5.3 Biasing Using a Collector-to-Base Feedback Resistor
3.5.4 Biasing Using a Constant-Current Source
3.6 Small-Signal Operation and Models
3.6.1 The Collector Current and the Transconductance
3.6.2 The Base Current and the Input Resistance at the Base
3.6.3 The Emitter Current and the Input Resistance at the Emitter
3.6.4 Voltage Gain
3.6.5 Separating the Signal and the DC Quantities
3.6.6 The Hybrid- Model
3.6.7 The T Model
3.6.8 Application of the Small-Signal Equivalent Circuits
3.6.9 Performing Small-Signal Analysis Directly on the Circuit Diagram
3.6.10 Augmenting the Small-Signal Models to Account for the Early Effect
3.6.11 Summary
3.7 Single-Stage BJT Amplifiers
3.7.1 The Basic Structure
3.7.2 Characterizing BJT Amplifiers
3.7.3 The Common-Emitter (CE) Amplifier
3.7.4 The Common-Emitter Amplifier with an Emitter Resistance
3.7.5 The Common-Base (CB) Amplifier
3.7.6 The Common-Collector (CC) Amplifier or Emitter Follower
3.7.7 Summary and Comparisons

Chapter 4: MOS Field-Effect Transistors (MOSFETs)
4.1 Device Structure and Physical Operation
4.1.1 Device Structure
4.1.2 Operation with No Gate Voltage
4.1.3 Creating a Channel for Current Flow
4.1.4 Applying a Small *vDS*
4.1.5 Operation as *vDS* Is Increased
4.1.6 Derivation of the *iD*?*vDS* Relationship
4.1.7 The *p*-Channel MOSFET
4.1.8 Complementary MOS or CMOS
4.1.9 Operating the MOS Transistor in the Subthreshold Region

4.2 Current?Voltage Characteristics
4.2.1 Circuit Symbol
4.2.2 The iD?vDS Characteristics
4.2.3 Finite Output Resistance in Saturation
4.2.4 Characteristics of the p-Channel MOSFET
4.2.5 The Role of the Substrate--The Body Effect
4.2.6 Temperature Effects
4.2.7 Breakdown and Input Protection
4.2.8 Summary
4.3 MOSFET Circuits at DC
4.4 The MOSFET as an Amplifier and as a Switch
4.4.1 Large-Signal Operation--The Transfer Characteristic
4.4.2 Graphical Derivation of the Transfer Characteristic
4.4.3 Operation as a Switch
4.4.4 Operation as a Linear Amplifier
4.4.5 Analytical Expressions for the Transfer Characteristic
4.4.6 A Final Remark on Biasing
4.5 Biasing in MOS Amplifier Circuits
4.5.1 Biasing by Fixing VGS
4.5.2 Biasing by Fixing VG and Connecting a Resistance in the Source
4.5.3 Biasing Using a Drain-to-Gate Feedback Resistor
4.5.4 Biasing Using a Constant-Current Source
4.5.5 A Final Remark
4.6 Small-Signal Operation and Models
4.6.1 The DC Bias Point
4.6.2 The Signal Current in the Drain Terminal
4.6.3 The Voltage Gain
4.6.4 Separating the DC Analysis and the Signal Analysis
4.6.5 Small-Signal Equivalent-Circuit Models
4.6.6 The Transconductance gm
4.6.7 The T Equivalent-Circuit Model
4.6.8 Modeling the Body Effect
4.6.9 Summary
4.7 Single-Stage MOS Amplifiers
4.7.1 The Basic Structure
4.7.2 Characterizing Amplifiers
4.7.3 The Common-Source (CS) Amplifier
4.7.4 The Common-Source Amplifier with a Source Resistance
4.7.5 The Common-Gate (CG) Amplifier
4.7.6 The Common-Drain or Source-Follower Amplifier
4.7.7 Summary and Comparisons

Chapter 5: Operational Amplifiers
5.1 The Ideal Op Amp
5.1.1 The Op-Amp Terminals

5.1.2 Function and Characteristics of the Ideal Op Amp
5.1.3 Differential and Common-Mode Signals
5.2 The Inverting Configuration
5.2.1 The Closed-Loop Gain
5.2.2 Effect of Finite Open-Loop Gain
5.2.3 Input and Output Resistances
5.2.4 An Important Application--The Weighted Summer
5.3 The Noninverting Configuration
5.3.1 The Closed-Loop Gain
5.3.2 Characteristics of the Noninverting Configuration
5.3.3 Effect of Finite Open-Loop Gain
5.3.4 The Voltage Follower
5.4 Difference Amplifiers
5.4.1 A Single Op-Amp Difference Amplifier
5.4.2 A Superior Circuit--The Instrumentation Amplifier
5.5 Effect of Finite Open-Loop Gain and Bandwidth on Circuit Performance
5.5.1 Frequency Dependence of the Open-Loop Gain
5.5.2 Frequency Response of Closed-Loop Amplifiers
5.6 Large-Signal Operation of Op Amps
5.6.1 Output Voltage Saturation
5.6.2 Output Current Limits
5.6.3 Slew Rate
5.6.4 Full-Power Bandwidth
5.7 DC Imperfections
5.7.1 Offset Voltage
5.7.2 Input Bias and Offset Currents
5.8 Integrators and Differentiators
5.8.1 The Inverting Configuration with General Impedances
5.8.2 The Inverting Integrator
5.8.3 The Op-Amp Differentiator
5.9 The BJT Differential Pair
5.9.1 Basic Operation
5.9.2 Large-Signal Operation
5.9.3 Small-Signal Operation

13. Lab works

14. References

1. *"Microelectronic Circuits" 5th Edition* – Adel S. Sedra, Kenneth C. Smith – Oxford University Press, ISBN: 978-0195142518
2. *"Electronic Circuit Analysis and Design" 2nd Edition* – Donald Neamen – McGraw-Hill, ISBN: 978-0072451948
3. *"Microelectronic Circuit Design" 3rd Edition* – Travis Blalock, Richard C. Jaeger – McGraw-Hill, ISBN: 978-0071102032

4. *“Microelectronic Circuit and Devices” 2nd Edition* - Mark N. Horenstein – Prentice Hall, ISBN: 978-0137013357

Chairman of the Scientific and Education Council

ET3096 Electrical and Electronic Circuits

1. Course Title: **Electrical and Electronic Circuits**

2. Course ID: ET3096

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Calculus and analytic geometry. General Physics

6. Requisites

- Prerequisites: - MI1026, PH1026
- Corequisites: -

7. Objectives and Expected Outcomes

- Provide enginering students other than electrical engineers an introduction to basic circuit and logic concepts of Electrical and Computer Engineering.

- Provide these students the basic tools of circuit analys and design that they will be expected to encounter in their profession, dealing especially with aspects of instrumentation, signal processing and poower distribution.

8. Description

DC and AC electrical circuit analysis methods, and analog and digital circuit design and analysis including operational amplifier linear circuits, digital combinational logic circuits, and computer interface circuits which combine both digital and analog devices for interfacing physical systems. Includes five laboratory sessions.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 20%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 30%

11. Course Materials

- *"Microelectronic Circuits" 5th Edition* – Adel S. Sedra, Kenneth C. Smith – Oxford University Press, ISBN: 978-0195142518

12. Course Topics

ELECTRICAL AND ELECTRONIC CIRCUITS

Course Developer:

Chapter 1 Circuit Analysis and Electrical Engineering

1.1 Introduction
1.2 Overview of the Text
1.3 Relationship of Circuit Analysis to Engineering
1.4 Analysis and Design
1.5 Computer-Aided Analysis
1.6 Successful Problem-Solving Strategies

Chapter 2 Basic Components and Electric Circuits

2.1 Introduction
2.2 Units and Scales
2.3 Charge, Current, Voltage, and Power
2.4 Voltage and Current Sources
2.5 Ohm's Law

Chapter 3 Voltage and Curent Laws

3.1 Introduction
3.2 Nodes, Paths, Loops, and Branches
3.3 Kirchoff' s Current Law
3.4 Kirchoff' s Voltage Law
3.5 The Single-Loop Circuit
3.6 The Single Node-Pair Circuit
3.7 Series and Parallel Connected Independent Sources
3.8 Resistors in Series and Parallel
3.9 Voltage and Current Division

Chapter 4 Basic Nodal and Mesh Analysis

4.1 Introduction
4.2 Nodal Analysis
4.3 The Supernode
4.4 Mesh Analysis
4.5 The Supermesh
4.6 Nodal vs. Mesh Analysis: A Comparison
4.7 Computer-Aided Circuit Analysis

Chapter 5 Useful Circuit Analysis Techniques

5.1 Introduction
5.2 Linearity and Superposition
5.3 Source Transformations
5.4 Thevenin and Norton Equivalent Circuits
5.5 Maximum Power Transfer
5.6 Delta-Wye Conversion

Chapter 6 The Operational Amplifier
6.1 Introduction
6.2 Background
6.3 The Ideal Op Amp: A Cordial Introduction
6.4 Cascaded Stages
6.5 A More Detailed Model for the Op Amp

Chapter 7 Capacitors and Inductors
7.1 Introduction
7.2 The Capacitor
7.3 The Inductor
7.4 Inductance and Capacitance Combinations
7.5 Consequences of Linearity
7.6 Simple Op Amp Circuits with Capacitors
7.7 Duality
7.8 Modeling Capacitors and Inductors with PSpice

Chapter 8 Basic RL and RC Circuits
8.1 Introduction
8.2 The Source-Free RL Circuit
8.3 Properties of the Exponential Response
8.4 The Source-Free RC Circuit
8.5 A More General Perspective
8.6 The Unit-Step Function
8.7 Driven RL Circuits
8.8 Natural and Forced Response
8.9 Driven RC Circuits

Chapter 9 The RLC Circuit
9.1 Introduction
9.2 The Source-Free Parallel Circuit
9.3 The Overdamped Parallel RLC Circuit
9.4 Critical Damping
9.5 The Underdamped Parallel RLC Circuit
9.6 The Source-Free Series RLC Circuit
9.7 The Complete Response of the RLC Circuit
9.8 The Lossless LC Circuit

Chapter 10 Sinusoidal Steady State Analysis
10.1 Introduction
10.2 Characteristics of Sinusoids
10.3 Forced Response to Sinusoidal Functions
10.4 The Complex Forcing Function
10.5 The Phasor
10.6 Phasor Relationships for R ,L ,and C
10.7 Impedance
10.8 Admittance

10.9 Nodal and Mesh Analysis
10.10 Superposition,Source Transformations,and Thévenin ’s Theorem
10.11 Phasor Diagrams

Chapter 11 AC Power Circuit Analysis
11.1 Introduction
11.2 Instantaneous Power
11.3 Average Power
11.4 Effective Values of Current and Voltage
11.5 Apparent Power and Power Factor
11.6 Complex Power

Chapter 12 Polyphase Circuits
12.1 Introduction
12.2 Polyphase Systems
12.3 Single-Phase Three-Wire Systems
12.4 Three-Phase Y-Y Connection
12.5 The Delta Connection
12.6 Power Measurement in Three-Phase Systems

Chapter 13 Magnetically Coupled Circuits
13.1 Introduction
13.2 Mutual Inductance
13.3 Energy Considerations
13.4 The Linear Transformer
13.5 The Ideal Transformer

13. Lab works

8 x 3-hour lab

14. References

1. *“Engineering Circuit Analysis”* 7th Ed - William H. Hayt, Jack Kemmerly, Steven M. Durbin – McGraw-Hill, ISBN: 9780073366616.
2. *“Basic Engineering Circuit Analysis: Problem-Solving Companion”* 7th Ed - J. David Irwin – Wiley, ISBN: 978-0471201922
3. *“Schaum's Outline of Basic Circuit Analysis”* 2nd Ed - John O'Malley – McGraw-Hill, ISBN: 978-0070478244
4. *“Circuit Analysis: Theory and Practice”* 4th Ed - Allan H. Robbins, Wilhelm C Miller - Delmar Cengage Learning, ISBN: 978-1418038618
5. “*PSpice for Basic Circuit Analysis”* 2nd Ed - Joseph G. Tront – McGraw-Hill, ISBN: 978-0073263199
6. *“Schaum’s Digital Principles”* 3rd Ed – Roger L. Tokheim – McGraw-Hill, ISBN: 978-0070650503

7. *"Circuit Analysis Demystified"* - David McMahon – McGraw-Hill, ISBN: 978-0071488983
8. *"Introductory Circuit Analysis"* 11st Ed - Robert L. Boylestad – Prentice Hall, ISBN: 978-0131730441

Chairman of the Scientific and Education Council

ET3116 Introduction to Microprocessor Systems

1. Course Title: **Introduction to Microprocessor Systems**

2. Course ID: ET3116

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Digital systems fundamentals. Assembly language programming. Electronics

6. Requisites

- Prerequisites: - ET3066, ET3096
- Corequisites: -

7. Objectives and Expected Outcomes

- Introduce students to features and technology of microprocessor systems. Gain experience in assembly language programming of microproessor peripherals and interrupt service routines, as well as data processing tasks.

8. Description

Introduction to architecture, operation, and application of microprocessors; microprocessor programming; address decoding; system timing; parallel, serial, and analog I/O; interrupts and direct memory access; interfacing to static and dynamic RAM; microcontrollers

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 25%
- Lab: 15%
- Projects: 40%
- Final exam: 30%

11. Course Materials

- *"Microcontrollers And Microcomputers: Principles of Software and Hardware Engineering"* – Frederick M. Cady – Oxford University Press, ISBN: 978-0195309508

12. Course Topics

INTRODUCTION TO MICROPROCESSOR SYSTEMS

Course Developer:

Chapter 1: Introduction

1.1. Computers, Microprocessors, Microcomputers, Microcontrollers
1.2. Some Basic Definitions
1.3. Notation
1.4. Study Plan

Chapter 2: The Picoprocessor: An Introduction to Computer Architecture

2.1. Introduction
2.2. Computer Operation Codes
2.3. Basic Computer Hardware
2.4. Computer Timing
2.5. More Instructions
2.6. Control Instructions
2.7. The Final Design
2.8. Chapter Summary Points
2.9. Problems

Chapter 3: Introduction to the CPU: Registers and Condition Codes

3.1. Introduction
3.2. CPU Register
3.3. Register Transfers
3.4. Your Real Processor's Registers
3.5. The Condition Code Register
3.6. The Programmer's Model
3.7. Chapter Summary Points
3.8. Problems

Chapter 5: Assembly Language Programming and Debugging

4.1. Introduction
4.2. The Assembler
4.3. The Code Location Problem
4.4. The Linker
4.5. The Librarian
4.6. The Loader
4.7. Assembly-Time, Link-Time, Load-Time, and Run-Time
4.8. Your Assembler
4.9. The Debugger
4.10. Typical Assembly Language Program Bugs
4.11. Tricks of the Trade
4.12. Chapter Summary Points
4.13. Problems

Chapter 5: Top-Down Software Design
5.1. The Need for Software Design
5.2. The Software Tree
5.3. The Software Development Process
5.4. Top-Down Design
5.5. Design Partitioning
5.6. Bottom-Up Design
5.7. The Real-World Approach
5.8. Types of Design Activity
5.9. Design Tools
5.10. Top-Down Debugging and Testing
5.11. Structured Programming in Assembly Language
5.12. Modular Design
5.13. Interprocess Communication

Chapter 6: Addressing Modes
6.1. Introduction
6.2. Addressing Terminology
6.3. Memory Architectures
6.4. Addressing Modes
6.5. Stack Addressing
6.6. Chapter Summary Points
6.7. Your Own Processor's Addressing Modes
6.8. Problems

Chapter 7: Computer Buses and Parallel Input/Output
7.1. Introduction
7.2. The Computer Bus
7.3. I/O Addressing
7.4. I/O Synchronization
7.5. More Bus Ideas
7.6. Simple I/O Devices
7.7. Programmable I/O Devices
7.8. More I/O Ideas
7.9. Chapter Summary Points
7.10. References and Other Reading
7.11. Problems

Chapter 8: Computer Memories
8.1. Introduction
8.2. Computer Types and Memory Maps
8.3. Semiconductor RAM
8.4. ROM Memory
8.5. Memory Timing Requirements
8.6. Putting it All Together

8.7. Conclusion and Chapter Summary Points
8.8. Further Reading
8.9. Problems

Chapter 9: Interrupts and Real-Time Events
9.1. Introduction
9.2. Interrupt System Specifications
9.3. Asynchronous Events and Internal Processor Timing
9.4. Internal CPU Interrupt Hardware
9.5. Multiple Sources of Interrupts
9.6. Sequential and Nested Interrupts
9.7. Simultaneous Interrupts - Priorities
9.8. Transferring Control to the Interrupt Service Routine
9.9. The Interrupt Service Routine
9.10. Interrupt Routine Returns
9.11. Other Interrupt Request Signals
9.12. Conclusion and Chapter Summary Points
9.13. Further Reading
9.14. Problems

Chapter 10: Serial Input/Output
10.1. Introduction
10.2. The Components of an Asynchronous Serial Communication System
10.3. Standards for the Serial I/O Interface
10.4. RS-232-C Interconnections
10.5. Standard Electrical Signal Levels
10.6. The UART
10.7. ASCII Data and Control Codes
10.8. Flow Control
10.9. Debugging and Trouble Shooting
10.10. Chapter Summary Points
10.11. Problems

Chapter 11: Analog Input and Output
11.1. Introduction
11.2. Data Acquisition and Conversion
11.3. Shannon's Sampling Theorem and Aliasing
11.4. Analog-to-Digital Conversion
11.5. Digital-to-Analog Conversion
11.6. Other Analog I/O Methods
11.7. Chapter Summary Points
11,8. Further Reading
11.9. Problems

13. Lab works

8 x 3-hour lab

14. References

1. *"Microcontrollers And Microcomputers: Principles of Software and Hardware Engineering"* – Frederick M. Cady – Oxford University Press, ISBN: 978-0195309508
2. *"Introduction to Microprocessors and Microcontrollers" 2nd Edition* – John Crisp – Newnes, ISBN: 978-0750659895
3. *"Embedded Microcontrollers"*– Todd D. Morton – Prentice Hall, ISBN: 978-0139075773
4. *"Fundamentals of Digital Logic and Microcomputer Design" 5th Edition* – M. Rafiquzzaman – John Wiley & Sons, ISBN: 978-0471727842
5. *"INTEL Microprocessors 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Prentium ProProcessor, Pentium II, III, 4" 7th Edition* – Barry B. Brey – Prentice Hall, ISBN: 978-0131195066

Chairman of the Scientific and Education Council

ET3118 Digial System Design and Synthesis

1. Course Title: **Digital System Design and Synthesis**

2. Course ID: ET3118

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Understanding and application of Boolean algebra. Ability to perform basic digital logic design. Basic programming skills

6. Requisites

- Prerequisites: - ET3066
- Corequisites: -

7. Objectives and Expected Outcomes

- Develop ability to use a hardware description language, simulation, and a logic synthesis tool in the design and verification of digital circuits.

- Understand design in a contemporary environment resulting from the use of deep-submicrometer implementation technologies and design reuse.

8. Description

Introduction to the use of hardware description languages and automated synthesis in design. Advanced design principles. Verilog and VHDL description languages. Synthesis for hardware description languages. Timing-oriented synthes. Relation of integrated circuit layout to timing-oriented design. Design for reuse.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab

10. Assessment

- Homeworks: 15%
- Lab: 15%
- Projects: 30%
- Mid-term: 20%
- Final exam: 20%

11. Course Materials

- *"Advanced Digital Design with the Verilog™ HDL"* – Michael D. Ciletti – Prentice Hall, ISBN: 978-0130891617

12. Course Topics

DIGIAL SYSTEM DESIGN AND SYNTHESIS

Course Developer:

Chapter 1. Introduction to Digital Design Methodology.

1.1 Design Methodology - An Introduction.
1.2 IC Technology Options. Overview.

Chapter 2. Review of Combinational Logic Design.

2.1 Combinational Logic and Boolean Algebra.
2.2 Theorems for Boolean Algebraic Minimization.
2.3 Representation of Combinational Logic.
2.4 Simplification of Boolean Expressions.
2.5 Glitches and Hazards.
2.6 Building Blocks for Logic Design.

Chapter 3. Fundamentals of Sequential Logic Design.

3.1 Storage Elements.
3.2 Flip-Flops.
3.3 Busses and Three-State Devices.
3.4 Design of Sequential Machines.
3.5 State Transition Graphs.
3.6 Design Example: BCD to Excess-3 Code Converter.
3.7 Serial Line Code Converter for Data Transmission.
3.8 State Reduction and Equivalent States.

Chapter 4. Introduction to Logic Design with Verilog.

4.1 Structural Models of Combinational Logic.
4.2 Logic Simulation, Design Verification, and Testbenches.
4.3 Propagation Delay.
4.4 Truth Table Models of Combinational and Sequential Logic with Verilog.

Chpter 5. Logic Design with Behavioral Models of Combinational and Sequential Logic.

5.1 Behavioral Modeling.
5.2 A Brief Look at Data Types for Behavioral Modeling.
5.3 Boolean Equation-Based Behavioral Models of Combinational Logic.
5.4 Propagation Delay and Continuous Assignments.
5.5 Latches and Level-Sensitive Circuits in Verilog.
5.6 Cyclic Behavioral Models of Flip-Flops and Latches.
5.7 Cyclic Behavior and Edge Detection.
5.8 A Comparison of Styles for Behavioral Modeling.
5.9 Behavioral Models of Multiplexers, Encoders, and Decoders.
5.10 Dataflow Models of a Linear Feedback Shift Register.
5.11 Modeling Digital Machines with Repetitive Algorithms.

5.12 Machines with Multi-Cycle Operations.
5.13 Design Documentation with Functions and Tasks: Legacy or Lunacy?
5.14 Algorithmic State Machine Charts for Behavioral Modeling.
5.15 ASMD Charts.
5.16 Behavioral Models of Counters, Shift Registers, and Register Files.
5.17 Switch Debounce, Metastability, and Synchronizers for Asynchronous Signals.
5.18 Design Example: Keypad Scanner and Encoder.

Chapter 6. Synthesis of Combinational and Sequential Logic.
6.1 Introduction to Synthesis.
6.2 Synthesis of Combinational Logic.
6.3 Synthesis of Sequential Logic with Latches.
6.4 Synthesis of Three-State Devices and Bus Interfaces.
6.5 Synthesis of Sequential Logic with Flip-Flops.
6.6 Synthesis of Explicit State Machines.
6.7 Registered Logic.
6.8 State Encoding.
6.9 Synthesis of Implicit State Machines, Registers, and Counters.
6.10 Resets.
6.11 Synthesis of Gated Clocks and Clock Enables.
6.12 Anticipating the Results of Synthesis.
6.13 Synthesis of Loops.
6.14 Design Traps to Avoid.
6.15 Divide and Conquer: Partitioning a Design.

Chapter 7. Design and Synthesis of Datapath Controllers.
7.1 Partitioned Sequential Machines.
7.2 Design Example: Binary Counter.
7.3 Design and Synthesis of a RISC Stored Program Machine.
7.4 Design Example: UART.

Chapter 8. Programmable Logic and Storage Devices.
8.1 Programmable Logic Devices.
8.2 Storage Devices.
8.3 Programmable Logic Array (PLA).
8.4 Programmable Array Logic (PALTM).
8.5 Programmability of PLDs.
8.6 Complex PLDs (CPLDs).
8.7 Altera MAX 7000 CPLD.
8.8 XILINX XC9500 CPLDs.
8.8 Field Programmable Gate Arrays.
8.9 Altera Flex 8000 FPGAs.
8.10 Altera Flex 10 FPGAs.
8.11 Altera Apex FPGAs.
8.12 Altera Chip Programmability.

8.13 XILINX XC4000 Series FPGA.
8.14 XILINX Spartan XL FPGAs.
8.15 XILINX Spartan II FPGAs.
8.16 XILINX Virtex FPGAs.
8.17 Embeddable and Programmable IP Cores for a System on a Chip (SOC).
8.18 Verilog-Based Design Flows For FPGAs.
8.19 Synthesis with FPGAs.

Chapter 9. Architectures and Algorithms for Digital Processors.
9.1 Algorithms, Nested Loop Programs, and Data Flow Graphs.
9.2 Design Example: Halftone Pixel Image Converter.
9.3 Digital Filters and Signal Processors.
9.4 Building Blocks for Signal Processors.
9.5 Pipelined Architectures.
9.6 Circular Buffers.
9.7 Dual-Port Fifos and Synchronization Across Clock Domains.

Chapter 10. Architectures for Arithmetic Processors.
10.1 Number Representation.
10.2 Functional Units for Addition and Subtraction.
10.3 Functional Units for Multiplication.
10.4 Multiplication of Signed Binary Numbers.
10.5 Multiplication of Fractions.
10.6 Functional Units for Division.

Chapter 11. Post-Synthesis Design Tasks.
11.1 Post-Synthesis Design Validation.
11.2 Post-Synthesis Timing Verification.
11.3 Elimination of ASIC Timing Violations.
11.4 False Paths.
11.5 Dynamically Sensitized Paths.
11.6 System Tasks for Timing Verification.
11.7 Fault Simulation and Testing.
11.8 Fault Simulation.
11.9 Fault Simulation with Verifault-XL.
11.10 JTAG Ports and Design for Testability and BIST.

13. Lab works

8 x 3-hour lab

14. References

1. *"Advanced Digital Design with the Verilog™ HDL"* – Michael D. Ciletti – Prentice Hall, ISBN: 978-0130891617

2. *"Digital Design: Principles and Practices" 4th Edition* – John F. Wakerly – Prentice Hall, ISBN: 978-0131863897
3. *"Digital Design and Verilog HDL Fundamentals"* – Joseph Cavanagh – CRC Press, ISBN: 978-1420074154
4. "FSM-based Digital Design using Verilog HDL" – Peter Minns, Ian Elliott –Wiley, ISBN: 978-0470060704

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ET3146 Electronic Circuits II

1. Course Title: **Electronic Circuits II**

2. Course ID: ET3146

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Understanding and application of Boolean algebra. Ability to perform basic digital logic design. Basic programming skills

6. Requisites

- Prerequisites: - ET3096
- Corequisites: -

7. Objectives and Expected Outcomes

- To focus on the design of amplifiers, filters, oscillators, A/D and D/A converters, and basic logic gates, with an emphasis on designs suitable for implementation in monolithic IC fabrication.

8. Description

A second course in modeling and application of semiconductor devices and integrated circuits. Advanced transistor amplifier analysis, including feedback effects. Design for power amplifiers, op-amps, analog filters, oscillators, A/D and D/A converters, and power converters. Introduction to transistor level design of CMOS digital circuits

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab

10. Assessment

- Homeworks: 10%
- Lab: 10%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- Final exam: 40%

11. Course Materials

- *"Microelectronic Circuits" 5th Edition* – Adel S. Sedra, Kenneth C. Smith – Oxford University Press, ISBN: 978-0195142518

12. Course Topics

ELECTRONIC CIRCUITS II

Course Developer:

Chapter 1: Feedback

1.1 The General Feedback Structure
1.2 Some Properties of Negative Feedback
    1.2.1 Gain Desensitivity
    1.2.2 Bandwidth Extension
    1.2.3 Noise Reduction
    1.2.4 Reduction in Nonlinear Distortion
1.3 The Four Basic Feedback Topologies
    1.3.1 Voltage Amplifiers
    1.3.2 Current Amplifiers
    1.3.3 Transconductance Amplifiers
    1.3.4 Transresistance Amplifiers
1.4 The Series?Shunt Feedback Amplifier
    1.4.1 The Ideal Situation
    1.4.2 The Practical Situation
    1.4.3 Summary
1.5 The Series?Series Feedback Amplifier
    1.5.1 The Ideal Case
    1.5.2 The Practical Case
    1.5.3 Summary
1.6 The Shunt?Shunt and Shunt?Series Feedback Amplifiers
    1.6.1 The Shunt?Shunt Configuration
    1.6.2 An Important Note
    1.6.3 The Shunt?Series Configuration
    1.6.4 Summary of Results
1.7 Determining the Loop Gain
    1.7.1 An Alternative Approach for Finding A ®
    1.7.2 Equivalence of Circuits from a Feedback-Loop Point of View
1.8 The Stability Problem
    1.8.1 Transfer Function of the Feedback Amplifier
    1.8.2 The Nyquist Plot
1.9 Effect of Feedback on the Amplifier Poles
    1.9.1 Stability and Pole Location
    1.9.2 Poles of the Feedback Amplifier
    1.9.3 Amplifier with Single-Pole Response
    1.9.4 Amplifier with Two-Pole Response
    1.9.5 Amplifiers with Three or More Poles
1.10 Stability Study Using Bode Plots
    1.10.1 Gain and Phase Margins
    1.10.2 Effect of Phase Margin on Closed-Loop Response

1.10.3 An Alternative Approach for Investigating Stability
1.11 Frequency Compensation

Chapter 2: Operational-Amplifier and Data-Converter Circuits
2.1 The Two-Stage CMOS Op Amp
2.1.1 The Circuit
2.1.2 Input Common-Mode Range and Output Swing
2.1.3 Voltage Gain
2.1.4 Frequency Response
2.1.5 Slew Rate
2.2 The Folded-Cascode CMOS Op Amp
2.2.1 The Circuit
2.2.2 Input Common-Mode Range and the Output Voltage Swing
2.2.3 Voltage Gain
2.2.4 Frequency Response
2.2.5 Slew Rate
2.2.6 Increasing the Input Common-Mode Range: Rail-to-Rail Input Operation
2.2.7 Increasing the Output Voltage Range: The Wide-Swing Current Mirror
2.3 The 741 Op-Amp Circuit
2.3.1 Bias Circuit
2.3.2 Short-Circuit Protection Circuitry
2.3.3 The Input Stage
2.3.4 The Second Stage
2.3.5 The Output Stage
2.3.6 Device Parameters
2.4 DC Analysis of the 741
2.4.1 Reference Bias Current
2.4.2 Input-Stage Bias
2.4.3 Input Bias and Offset Currents
2.4.4 Input Offset Voltage
2.4.5 Input Common-Mode Range
2.4.6 Second-Stage Bias
2.4.7 Output-Stage Bias
2.4.8 Summary
2.5 Small-Signal Analysis of the 741
2.5.1 The Input Stage
2.5.2 The Second Stage
2.5.3 The Output Stage
2.6 Gain, Frequency Response, and Slew Rate of the 741
2.6.1 Small-Signal Gain
2.6.2 Frequency Response
2.6.3 A Simplified Model
2.6.4 Slew Rate
2.6.5 Relationship Between ft and SR
2.7 Data Converters--An Introduction

2.7.1 Digital Processing of Signals
2.7.2 Sampling of Analog Signals
2.7.3 Signal Quantization
2.7.4 The A/D and D/A Converters as Functional Blocks
2.8 D/A Converter Circuits
2.8.1 Basic Circuit Using Binary-Weighted Resistors
2.8.2 R-2R Ladders
2.8.3 A Practical Circuit Implementation
2.8.4 Current Switches
2.9 A/D Converter Circuits
2.9.1 The Feedback-Type Converter
2.9.2 The Dual-Slope A/D Converter
2.9.3 The Parallel or Flash Converter
2.9.4 The Charge-Redistribution Converter

Chapter 3: Digital CMOS Logic Circuits
3.1 Digital Circuit Design: An Overview
3.1.1 Digital IC Technologies and Logic-Circuit Families
3.1.2 Logic-Circuit Characterization
3.1.3 Styles for Digital System Design
3.1.4 Design Abstraction and Computer Aids
3.2 Design and Performance Analysis of the CMOS Inverter
3.2.1 Circuit Structure
3.2.2 Static Operation
3.2.3 Dynamic Operation
3.2.4 Dynamic Power Dissipation
3.3 CMOS Logic-Gate Circuits
3.3.1 Basic Structure
3.3.2 The Two-Input NOR Gate
3.3.3 The Two-Input NAND Gate
3.3.4 A Complex Gate
3.3.5 Obtaining the PUN from the PDN and Vice Versa
3.3.6 The Exclusive-OR Function
3.3.7 Summary of the Synthesis Method
3.3.8 Transistor Sizing
3.3.9 Effects of Fan-In and Fan-Out on Propagation Delay
3.4 Pseudo-NMOS Logic Circuits
3.4.1 The Pseudo-NMOS Inverter
3.4.2 Static Characteristics
3.4.3 Derivation of the VTC
3.4.4 Dynamic Operation
3.4.5 Design
3.4.6 Gate Circuits
3.4.7 Concluding Remarks
3.5 Pass-Transistor Logic Circuits

3.5.1 An Essential Design Requirement
3.5.2 Operation with NMOS Transistors as Switches
3.5.3 The Use of CMOS Transmission Gates as Switches
3.5.4 Pass-Transistor Logic Circuit Examples
3.5.5 A Final Remark
3.6 Dynamic Logic Circuits
3.6.1 Basic Principle
3.6.2 Nonideal Effects
3.6.3 Domino CMOS Logic
3.6.4 Concluding Remarks

Chapter 4: Memory and Advanced Digital Circuits
4.1 Latches and Flip-flops
4.1.1 The Latch
4.1.2 The SR Flip-Flop
4.1.3 CMOS Implementation of SR Flip-Flops
4.1.4 A Simpler CMOS Implementation of the Clocked SR Flip-Flop
4.1.5 D Flip-Flop Circuits
4.2 Multivibrator Circuits
4.2.1 A CMOS Monostable Circuit
4.2.2 An Astable Circuit
4.2.3 The Ring Oscillator
4.3 Semiconductor Memories: Types and Architectures
4.3.1 Memory-Chip Organization
4.3.2 Memory-Chip Timing
4.4 Random-Access Memory (RAM) Cells
4.4.1 Static Memory Cell
4.4.2 Dynamic Memory Cell
4.5 Sense Amplifiers and Address Decoders
4.5.1 The Sense Amplifier
4.5.2 The Row-Address Decoder
4.5.3 The Column-Address Decoder
4.6 Read-Only Memory (ROM)
4.6.1 A MOS ROM
4.6.2 Mask-Programmable ROMs
4.6.3 Programmable ROMs (PROMs and EPROMs)
4.7 Emitter-Coupled Logic (ECL)
4.7.1 The Basic Principle
4.7.2 ECL Families
4.7.3 The Basic Gate Circuit
4.7.4 Voltage Transfer Characteristics
4.7.5 Fan-Out
4.7.6 Speed of Operation and Signal Transmission
4.7.7 Power Dissipation
4.7.8 Thermal Effects

4.7.9 The Wired-OR Capability
4.7.10 Some Final Remarks
4.8 BiCMOS Digital Circuits
4.8.1 The BiCMOS Inverter
4.8.2 Dynamic Operation
4.8.3 BiCMOS Logic Gates

Chapter 5: Filters and Tuned Amplifiers
5.1 Filter Transmission, Types, and Specification
5.1.1 Filter Transmission
5.1.2 Filter Types
5.1.3 Filter Specification
5.2 The Filter Transfer Function
5.3 Butterworth and Chebyshev Filters
5.3.1 The Butterworth Filter
5.3.2 The Chebyshev Filter
5.4 First-Order and Second-Order Filter Functions
5.4.1 First-Order Filters
5.4.2 Second-Order Filter Functions
5.5 The Second-Order LCR Resonator
5.5.1 The Resonator Natural Modes
5.5.2 Realization of Transmission Zeros
5.5.3 Realization of the Low-Pass Function
5.5.4 Realization of the High-Pass Function
5.5.5 Realization of the Bandpass Function
5.5.6 Realization of the Notch Functions
5.5.7 Realization of the All-Pass Function
5.6 Second-Order Active Filters Based on Inductor Replacement
5.6.1 The Antoniou Inductance-Simulation Circuit
5.6.2 The Op Amp?RC Resonator
5.6.3 Realization of the Various Filter Types
5.6.4 The All-Pass Circuit
5.7 Second-Order Active Filters Based on the Two-Integrator-Loop Topology
5.7.1 Derivation of the Two-Integrator-Loop Biquad
5.7.2 Circuit Implementation
5.7.3 An Alternative Two-Integrator-Loop Biquad Circuit
5.7.4 Final Remarks
5.8 Single-Amplifier Biquadratic Active Filters
5.8.1 Synthesis of the Feedback Loop
5.8.2 Injecting the Input Signal
5.8.3 Generation of Equivalent Feedback Loops
5.9 Sensitivity
5.10 Switched-Capacitor Filters
5.10.1 The Basic Principle
5.10.2 Practical Circuits

5.10.3 A Final Remark
5.11 Tuned Amplifiers
5.11.1 The Basic Principle
5.11.2 Inductor Losses
5.11.3 Use of Transformers
5.11.4 Amplifiers with Multiple Tuned Circuits
5.11.5 The Cascode and the CC?CB Cascade
5.11.6 Synchronous Tuning
5.11.7 Stagger-Tuning

Chapter 6: Signal Generators And Waveform-Shaping Circuits
6.1 Basic Principles of Sinusoidal Oscillators
6.1.1 The Oscillator Feedback Loop
6.1.2 The Oscillation Criterion
6.1.3 Nonlinear Amplitude Control
6.1.4 A Popular Limiter Circuit for Amplitude Control
6.2 Op Amp?RC Oscillator Circuits
6.2.1 The Wien-Bridge Oscillator
6.2.2 The Phase-Shift Oscillator
6.2.3 The Quadrature Oscillator
6.2.4 The Active-Filter-Tuned Oscillator
6.2.5 A Final Remark
6.3 LC and Crystal Oscillators
6.3.1 LC-Tuned Oscillators
6.3.2 Crystal Oscillators
6.4 Bistable Multivibrators
6.4.1 The Feedback Loop
6.4.2 Transfer Characteristics of the Bistable Circuit
6.4.3 Triggering the Bistable Circuit
6.4.4 The Bistable Circuit as a Memory Element
6.4.5 A Bistable Circuit with Noninverting Transfer Characteristics
6.4.6 Application of the Bistable Circuit as a Comparator
6.4.7 Making the Output Levels More Precise
6.5 Generation of Square and Triangular Waveforms Using Astable Multivibrators
6.5.1 Operation of the Astable Multivibrator
6.5.2 Generation of Triangular Waveforms
6.6 Generation of a Standardized Pulse--The Monostable Multivibrator
6.7 Integrated-Circuit Timers
6.7.1 The 555 Circuit
6.7.2 Implementing a Monostable Multivibrator Using the 555 IC
6.7.3 An Astable Multivibrator Using the 555 IC
6.8 Nonlinear Waveform-Shaping Circuits
6.8.1 The Breakpoint Method
6.8.2 The Nonlinear-Amplification Method

Chapter 7: Output Stages and Power Amplifiers

Introduction
7.1 Classification of Output Stages
7.2 Class A Output Stage
    7.2.1 Transfer Characteristic
    7.2.2 Signal Waveforms
    7.2.3 Power Dissipation
    7.2.4 Power-Conversion Efficiency
7.3 Class B Output Stage
    7.3.1 Circuit Operation
    7.3.2 Transfer Characteristic
    7.3.3 Power-Conversion Efficiency
    7.3.4 Power Dissipation
    7.3.5 Reducing Crossover Distortion
    7.3.6 Single-Supply Operation
7.4 Class AB Output Stage
    7.4.1 Circuit Operation
    7.4.2 Output Resistance
    7.5 Biasing the Class AB Circuit
    7.5.1 Biasing Using Diodes
    7.5.2 Biasing Using the VBE Multiplier
7.6 Power BJTs
    7.6.1 Junction Temperature
    7.6.2 Thermal Resistance
    7.6.3 Power Dissipation Versus Temperature
    7.6.4 Transistor Case and Heat Sink
    7.6.5 The BJT Safe Operating Area
    7.6.6 Parameter Values of Power Transistors
7.7 Variations on the Class AB Configuration
    7.7.1 Use of Input Emitter Followers
    7.7.2 Use of Compound Devices
    7.7.3 Short-Circuit Protection
    7.7.4 Thermal Shutdown
7.8 IC Power Amplifiers
    7.8.1 A Fixed-Gain IC Power Amplifier
    7.8.2 Power Op Amps
    7.8.3 The Bridge Amplifier
7.9 MOS Power Transistors
    7.9.1 Structure of the Power MOSFET
    7.9.2 Characteristics of Power MOSFETs
    7.9.3 Temperature Effects
    7.9.4 Comparison with BJTs
    7.9.5 A Class AB Output Stage Utilizing MOSFETs

13. Lab works

8 x 3-hour lab

14. References

1. *"Microelectronic Circuits" 5th Edition* – Adel S. Sedra, Kenneth C. Smith – Oxford University Press, ISBN: 978-0195142518
2. *"Electronic Circuit Analysis and Design" 2nd Edition* – Donald Neamen – McGraw-Hill, ISBN: 978-0072451948
3. *"Microelectronic Circuit Design" 3rd Edition* – Travis Blalock, Richard C. Jaeger – McGraw-Hill, ISBN: 978-0071102032
4. *"Microelectronic Circuit and Devices" 2nd Edition* - Mark N. Horenstein – Prentice Hall, ISBN: 978-0137013357

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ET3148 Digial Circuits and Components

1. Course Title: **Digital Circuits and Components**

2. Course ID: ET3148

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Ability to perform circuit analysis. Ability to perform logic design. An understanding of basic solid state device concepts and models. Familiarity with basic EDA tools

6. Requisites

- Prerequisites: - ET3066, ET3096
- Corequisites: -

7. Objectives and Expected Outcomes

- Fundamental understanding of digital integrated circuits.

8. Description

Principles and characterization of logic circuits. Design and analysis techniques for applied logic circuits. Transmission lines in digital applications. Families of circuit logic currently in use and their characteristics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab

10. Assessment

- Homeworks: 20%
- Lab: 20%
- Projects: 20%
- Mid-term: 20%
- Final exam: 20%

11. Course Materials

- *"Digital Integrated Circuits"* 2nd Ed - Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic – Prentice Hall, ISBN: 978-0130909961

12. Course Topics

DIGITAL CIRCUIT AND COMPONENTS

Course Developer:

Chapter 1. Introduction.

1.1 A Historical Perspective.

1.2 Issues in Digital Integrated Circuit Design.

1.3 Quality Metrics of a Digital Design.

1.4 CMOS Technologies

Chapter 2. Design rule and layout.

2.1 Packaging Integrated Circuits.

2.2 CMOS Fabrication and Layout

2.3 Layout Design Rules

Chapter 3. Implementation Strategies for Digital ICS

3.1 From Custom to Semicustom and Structured-Array Design Approaches.

3.2 Custom Circuit Design.

3.3 Cell-Based Design Methodology.

3.4 Array-Based Implementation Approaches

Chapter 4. CMOS Inverter and Static CMOS Design

4.1 Evaluating the Robustness of the CMOS Inverter: The Static Behavior

4.2 Static CMOS Design

Chapter 5 Dynamic CMOS Design

5.1 Dynamic CMOS Design

Chapter 6 Wire and Interconnect

6.1 Interconnect Parameters—Capitance, Resistance, and Inductance

6.2 Electrical Wire Models

6.3 SPICE Wire Models

Chapter 7 Logical effort and Tranzitor sizing

7.1 Logical effort and Tranzitor sizing

Chapter 8 Adder, shifter, multiplier

8.1 Datapaths in Digital Processor Architectures

8.2 The Adder

8.3 The shifter

8.4 The multiplier

Chapter 9 Power, Energy, and Energy Delay

9.1 Power, Energy, and Energy-Delay

9.2 Power & Speed Trade-Offs in Datapath Structures

Chapter 10 Sequential Logic Circuits and Timing Issues

10.1Dynamic Latches and Registers

10.2 Timing Classification of Digital Systems.

10.3 Synchronous Design—An In-Depth Perspective.

10.4 Self-Timed Circuit Design.

Chapter 11 Memory

11.1 The Memory Core.

11.2 Memory Peripheral Circuitry

11.3 Memory Reliability and Yield.

11.4 Power Dissipation in Memories.

11.5 Case Studies in Memory Design

Chapter 12 System-Level Power Reduction, Clock-Distribution and Synthesis

12.1 Self-Timed Circuit Design

12.2 Clock Synthesis and Synchronization Using a Phased-Locked Loop

Chapter 13 Advanced Interconnect Techniques

13.1 Advanced Interconnect Techniques

13. Lab works

8 x 3-hour lab

14. References

1. *"Digital Integrated Circuits"* 2nd Ed - Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic – Prentice Hall, ISBN: 978-0130909961
2. *"CMOS VLSI Design: A Circuits and Systems Perpective"* 3rd Ed - Neil H.E. Weste, David Harris – Addison Wesley, ISBN: 978-0321149015
3. *"Digital Integrated Circuit Design"* – Ken Martin - Oxford University Press, ISBN: 978-0195125849
4. *"Digital Integrated Circuit Design: From VLSI Architectures to CMOS Fabrication"* - Hubert Kaeslin – Cambridge University Press, ISBN: 9780521882675
5. *"Digital VLSI Design with Verilog: A Textbook from Silicon Valley Technical Institute"* - Williams John – Springer – ISBN: 978-1402084454
6. *"Modern VLSI Design: System-on-Chip Design"* – Wayne Wolf – Prentice Hall, ISBN: 978-0130619709

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ET3166 Introduction to Data Structures

1. Course Title: **Introduction to Data Structures**

2. Course ID: ET3166

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic programming skill.

6. Requisites

- Prerequisites: - ET3006
- Corequisites: -

7. Objectives and Expected Outcomes

- Students should have ability to develop, implement and analyse efficient data structures and algorithms using an object-oriented programming language.

8. Description

Study of data structures (including stacks, queues, trees, graphs, and hash tables) and their applications. Development, implementation, and analysis of efficient data structures and algorithms (including sorting and searching). Experience in use of an object-oriented programming language.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab

10. Assessment

- Homeworks: 15%
- Projects: 30%
- 1st mid-term: 15%
- 2nd mid-term: 15%
- Final exam: 25%

11. Course Materials

- *"Data Structures and Abstractions with Java" 2nd Edition* – Frank M. Carrano – Prentice Hall, ISBN: 978-0132370455

12. Course Topics

INTRODUCTION TO DATA STRUCTURES

Course Developer:

Chapter 1: Java Classes

1.1 Objects and Classes
1.2 Using the Methods in a Java Class
1.3 Defining a Java Class
1.4 Enumeration as a Class
1.5 Chapter Summary
1.6 Programming Tips
1.7 Exercises
1.8 Projects

Chapter 2: Creating Classes from Other Classes

2.1Composition
2.2 Type Compatibility and Base Classes
2.3 Polymorphism
2.4 Chapter Summary
2.5 Programming Tips
2.6 Exercises
2.7 Projects

Chapter 3: Designing Classes

3.1 Encapsulation
3.2 Specifying Methods
3.3 Java Interfaces
3.4 Choosing Classes
3.5 Reusing Classes
3.6 Chapter Summary
3.7 Programming Tips
3.8 Exercises
3.9 Projects

Chapter 4: Lists

4.1 Specifications for the ADT List
4.2 Using the ADT List
4.3 Using a List Is Like Using a Vending Machine
4.4 Java Class Library: The Interface List
4.5 Chapter Summary
4.6 Programming Tips
4.7 Exercises
4.8 Projects

Chapter 5: List Implementations That Use Arrays

5.1 Using a Fixed-Size Array to Implement the ADT List
5.2 Using Array Expansion to Implement the ADT List

5.3 Java Class Library: The Classes ArrayList and Vector
5.4 The Pros and Cons of Using an Array to Implement the ADT List
5.5 Chapter Summary
5.6 Programming Tips
5.7 Exercises
5.8 Projects

Chapter 6: A List Implementation That Links Data
6.1 Linked Data
6.2 A Linked Implementation of the ADT List
6.3 Testing the Incomplete Implementation
6.4 Chapter Summary
6.5 Programming Tips
6.6 Exercises
6.7 Projects

Chapter 7: Completing the Linked Implementation of a List
7.1 Removing an Item from a Linked Chain
7.2 Completing the Linked Implementation of the ADT List
7.3 A Class Node That Has Set and Get Methods
7.4 Tail References
7.5 The Pros and Cons of Using a Chain to Implement the ADT List
7.6 Java Class Library: The Class LinkedList
7.7 Chapter Summary
7.8 Exercises
7.9 Projects

Chapter 8: Stacks
8.1 Specifications of the ADT Stack
8.2 Using a Stack to Process Algebraic Expressions
8.3 Using a Stack Instead of Recursion
8.4 Programming Tip
8.5 Exercises
8.6 Projects

Chapter 9: Stack Implementations
9.1 A Linked Implementation
9.2 An Array-Based Implementation
9.3 A Vector-Based Implementation
9.4 Exercises
9.5 Projects

Chapter 10: Queues, Deques, and Priority Queues
10.1 Specifications of the ADT Queue
10.2 Using a Queue to Simulate a Waiting Line
10.3 Using a Queue to Compute the Capital Gain in a Sale of Stock
10.4 Java Class Library: The Interface Queue

10.5 Specifications of the ADT Deque
10.6 Using a Deque to Compute the Capital Gain in a Sale of Stock
10.7 Using a Priority Queue to Track Your Assignments
10.8 Chapter Summary
10.9 Programming Tip
10.10 Exercises
10.11 Projects

Chapter 11: Queue, Deque, and Priority Queue Implementations
11.1 A Linked Implementation of a Queue
11.2 An Array-Based Implementation of a Queue
11.3 A Vector-Based Implementation of a Queue
11.4 Circular Linked Implementations of a Queue
11.5 Java Class Library: The Class AbstractQueue
11.6 A Doubly Linked Implementation of a Deque
11.7 Possible Implementations of a Priority Queue
11.8 Java Class Library: The Class PriorityQueue
11.9 Chapter Summary
11.10 Programming Tip
11.11 Exercises
11.12 Projects

Chapter 12: Recursion
12.1 What Is Recursion?
12.2 Tracing a Recursive Method
12.3 Recursive Methods That Return a Value
12.4 Recursively Processing an Array
12.5 Recursively Processing a Linked Chain
12.6 A Simple Solution to a Difficult Problem
12.7 A Poor Solution to a Simple Problem
12.8 Tail Recursion
12.9 Mutual Recursion
12.10 Chapter Summary
12.11 Programming Tips
12.12 Exercises

Chapter 13: Searching
13.1 The Problem
13.2 Searching an Unsorted Array
13.3 Searching a Sorted Array
13.4 Searching an Unsorted Chain
13.5 Searching a Sorted Chain
13.6 Choosing a Search Method
13.7 Chapter Summary
13.8 Programming Tip
13.9 Exercises

13.10 Projects

Chapter 14: Trees
14.1 Tree Concepts
14.2 Traversals of a Tree
14.3 Java Interfaces for Trees
14.4 Chapter Summary
14.5 Exercises
14.6 Projects

Chapter 15: Tree Implementations
15.1 The Nodes in a Binary Tree
15.2 An Implementation of an Expression Tree
15.3 General Trees
15.4 Chapter Summary
15.5 Programming Tips
15.6 Exercises
15.7 Projects

Chapter 16: A Binary Search Tree Implementation
16.1 Getting Started
16.2 Traversing
16.3 Adding an Entry
16.4 Removing an Entry
16.5 The Efficiency of Operations
16.6 An Implementation of the ADT Dictionary
16.7 Exercises
16.8 Projects

Chapter 17: A Heap Implementation
17.1 Reprise: The ADT Heap
17.2 Using an Array to Represent a Heap
17.3 Adding an Entry
17.4 Heap Sort
17.5 Chapter Summary
17.6 Exercises
17.7 Projects

Chapter 18: Introducing Hashing
18.1 What Is Hashing?
18.2 Hash Functions
18.3 Resolving Collisions
18.4 Chapter Summary
18.5 Exercises
18.6 Projects

Chapter 19: Hashing as a Dictionary Implementation
19.1 The Efficiency of Hashing
19.2 Rehashing
19.3 Comparing Schemes for Collision Resolution
19.4 A Dictionary Implementation That Uses Hashing
19.5 Chapter Summary
19.6 Exercises
19.7 Projects

Chapter 20: Graphs
20.1 Some Examples and Terminology
20.2 Traversals
20.3 Topological Order
20.4 Paths
20.5 Chapter Summary
20.6 Exercises
20.7 Projects

Chapter 21: Graph Implementations
21.1 An Overview of Two Implementations
21.2 Vertices and Edges
21.3 1An Implementation of the ADT Graph
21.4 Exercises
21.5 Projects

Chapter 22: An Introduction to Sorting
22.1 Organizing Java Methods That Sort an Array
22.2 Selection Sort
22.3 Insertion Sort
22.4 Shell Sort
22.5 Comparing the Algorithms
22.6 Chapter Summary
22.7 Programming Tip
22.8 Exercises
22.9 Projects

Chapter 23: Faster Sorting Methods
23.1 Merge Sort
23.2 Quick Sort
23.3 Radix Sort
23.4 Comparing the Algorithms
23.5 Chapter Summary
23.6 Exercises
23.7 Projects

Chapter 24: Sorted Lists
24.1 Specifications for the ADT Sorted List

24.2 A Linked Implementation
24.3 An Implementation That Uses the ADT List
24.4 Chapter Summary
24.5 Exercises
24.6 Projects

13. Lab works

14. References

1. *"Data Structures and Abstractions with Java" 2nd Edition* – Frank M. Carrano – Prentice Hall, ISBN: 978-0132370455
2. *"Data Structures with Java"*– William H. Ford, William R. Topp – Prentice Hall, ISBN: 978-0130477248
3. *"Data Structures Outside-In with Java"* – Sesh Venugopal – Prentice Hall, ISBN: 978-0131986190
4. "*Data Structures with Java*" 5th Edition – John R. Hubbard, Anita Huray – Prentice Hall, ISBN: 978-0130933744
5. "*From Data Structures with Java*" - Darrel Ince – Palgrave Macmillan, ISBN: 978-0333774441

Chairman of the Scientific and Education Council

ET3176 Biomedical Engineering Design

1. Course Title: **Biomedical Engineering Design**

2. Course ID: ET3176

3. Course Units: **1(0-2-0-4)**

- Lecture: 00 hours
- Seminar: 30 hours
- Lab:

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic chemistry, calculus, and statics

6. Requisites

- Prerequisites: - So standing in biomedical engineering
- Corequisites: -

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley

12. Course Topics

BIOMEDICAL ENGINEERING DESIGN

Course Developer:

Chapter 1. BME Design Requirements

1.1 Animal research and ethics
1.2 FDA medical device regulations
1.3 Human Subjects Research
1.4 Impact of engineering solutions in a global and societal context
1.5 Intellectual Property
1.6 IRB Orientation Lecture
1.7 Teamwork

Chapter 2. Usability and Accessibility in BME Design

2.1 Introduction
2.2 Difficulty of Use or Access of Medical Devices
2.3 Human Factors and Ergonomics Issues for Health Care Professionals
2.4 Applying the Principles of Universal Design (UD) to Medical Devices
2.5 Principle 1: Equitable Use
2.6 Principle 2: Flexibility in Use
2.7 Principle 3: Simple and Intuitive
2.8 Principle 4: Perceptible Information
2.9 Principle 5: Tolerance for Error
2.10 Principle 6: Low Physical Effort
2.11 Principle 7: Size and Space for Approach and Use
2.12 Ergonomics and Usability Evaluation of Designs
2.13 Standards for Medical Devices

Chapter 3. Steps in the Design Process

3.1 Problem Definition
3.2 Preliminary Design Ideas
3.3 Choose Single Design to Pursue
3.4 Design Detailing
3.5 Evaluate Design
3.6 Prototype
3.7 Evaluation of Prototype
3.8 Written reports

Chapter 4. Some Project Titles in Biomedical Engineering

4.1 System for pH measurement inside incubator
4.2 System to monitor epilepsy in rodents
4.3 Device to aid communication between intubated patients and care providers
4.4 Measurement of pulse transit time (pulse_transit_time)
4.5 DSP application in medical instrumentation (TI_project)
4.6 Digital Braille watch (braille_watch)

4.7 Sensory substitution device for hearing impairment (sensory_substitution)
4.8 Permanently implantable inductive ICP monitor (ICP_monitor)
4.9 Development of an exhaled breath condensate system for use during exercise (condensate)
4.10 Medication adherence measurement device (medication_adherence)
4.11 Delivery of inhaled drugs through CPAP (cpap)
4.12 Device to assist in removal of pills from bubble wrapped packaging (pill_removal)
4.13 Leg positioner to facilitate placement of central venous catheters in the ICU
4.14 Physical 3D model of the larynx with moving parts (larynx_model)
4.15 Umbilical cord model for umbilical vein catheterization training (umbilical)
4.16 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
4.17 Assistive device to augment strength in the weak hand of a stroke patient (finger_device)
4.18 Motorized wheelchair mounting system (wheelchair_mount)
4.19 National Design Competition: Accessible Incontinence Control Device
4.20 Method to determine failure in embedded biomaterials (embedded_biomaterials)
4.21 Mechanical testing system coupled with an environmental chamber
4.22 Mechanical testing system coupled with an environmental chamber
4.23 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
4.24 Blinking orbital prosthesis (orbital_prosthesis)
4.25 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
4.26 Design of a heating pad for a microPET/CT scanner (heating_pad)
4.27 Handheld device to measure tumor size
4.28 Device to enhance/monitor back exercise
4.29 Development of optimal design for cooling patients in flight (hypothermia)
4.30 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device (pill_cap)
4.31 Device for dilating esophageal strictures (esophageal_strictures)
4.31 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
4.33 Computer mouse replacement
4.34 Device for the presentation of olfactory stimuli to monkeys
4.35 Incubation chamber for microscope (microscope)
4.36 Multi-IV fluid feed system
4.37 Mechanical testing system coupled with an environmental chamber (chamber)
4.38 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
4.39 National Design Competition: Innovations in accessible medical instrumentation
4.40 Artificial burning limb (burning_limb)
4.41 Syringe for injectable fillers (syringe)
4.42 Endotracheal tube securing device (endotracheal_device)
4.43 Laparoscopic banding device (banding_device)
4.44 High speed video system for laryngeal imaging
4.45 System to study excised larynges
4.46 Low cost visualization to assist epidural and spinal needle placements
4.47 Localization of peripheral nerves

4.48 Minimizing magnetic interference in the MRI environment
4.49 Measurement device to increase the tactile feedback in regional blocks
4.50 Output device to increase the tactile feedback in regional blocks
4.51 Automatic feedback of neuromuscular stimulation in regional block
4.52 Wireless man-machine communication
4.53 IV drug project

13. Lab works

14. References

1. Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.
2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
3. Moore, J. H., Davis, C. C., and Coplan, M. A. 1989. Building Scientific Apparatus: A Practical Guide to Design and Construction. Addison-Wesley.
4. Pahl, G., Beitz, W. 1988. Engineering Design, A Systematic Approach. London, Springer-Verlag
5. Wilcox, A. 1990. Engineering Design For Electrical Engineers. Englewood Cliffs N.J., Prentice- Hall
6. Ingle, K. A. 1994. Reverse Engineering. New York, McGraw-Hill Inc
7. Carper, K. L. 1989. Forensic Engineering. New York, Elsevier
8. Middendorf, W. H. 1990. Design of Devices and Systems. New York, Marcel Dekker
9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
10. Burgess, J. 1986. Designing for Humans: The Human Factor in Engineering. Princeton, Petrocelli Books
11. Foltz, R., Penn, T. 1989. Protecting Engineering Ideas & Inventions. Cleveland OH, Penn Institute

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ET3178 Biomedical Engineering Design

1. Course Title: **Biomedical Engineering Design**

2. Course ID: ET3178

3. Course Units: **1(0-2-0-4)**

- Lecture: 00 hours
- Seminar: 30 hours
- Lab:

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basics of the design process

6. Requisites

- Prerequisites: -
- Corequisites: - ET4516

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley

12. Course Topics

BIOMEDICAL ENGINEERING DESIGN

Course Developer:

Some Project Titles in Biomedical Engineering

1 System for pH measurement inside incubator
2 System to monitor epilepsy in rodents
3 Device to aid communication between intubated patients and care providers
4 Measurement of pulse transit time (pulse_transit_time)
5 DSP application in medical instrumentation (TI_project)
6 Digital Braille watch (braille_watch)
7 Sensory substitution device for hearing impairment (sensory_substitution)
8 Permanently implantable inductive ICP monitor (ICP_monitor)
9 Development of an exhaled breath condensate system for use during exercise (condensate)
10 Medication adherence measurement device (medication_adherence)
11 Delivery of inhaled drugs through CPAP (cpap)
12 Device to assist in removal of pills from bubble wrapped packaging (pill_removal)
13 Leg positioner to facilitate placement of central venous catheters in the ICU
14 Physical 3D model of the larynx with moving parts (larynx_model)
15 Umbilical cord model for umbilical vein catheterization training (umbilical)
16 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
17 Assistive device to augment strength in the weak hand of a stroke patient (finger_device)
18 Motorized wheelchair mounting system (wheelchair_mount)
19 National Design Competition: Accessible Incontinence Control Device
20 Method to determine failure in embedded biomaterials (embedded_biomaterials)
21 Mechanical testing system coupled with an environmental chamber
22 Mechanical testing system coupled with an environmental chamber
23 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
24 Blinking orbital prosthesis (orbital_prosthesis)
25 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
26 Design of a heating pad for a microPET/CT scanner (heating_pad)
27 Handheld device to measure tumor size
28 Device to enhance/monitor back exercise
29 Development of optimal design for cooling patients in flight (hypothermia)
30 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device (pill_cap)
31 Device for dilating esophageal strictures (esophageal_strictures)
31 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
33 Computer mouse replacement
34 Device for the presentation of olfactory stimuli to monkeys
35 Incubation chamber for microscope (microscope)
36 Multi-IV fluid feed system
37 Mechanical testing system coupled with an environmental chamber (chamber)

38 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
39 National Design Competition: Innovations in accessible medical instrumentation
40 Artificial burning limb (burning_limb)
41 Syringe for injectable fillers (syringe)
42 Endotracheal tube securing device (endotracheal_device)
4.43 Laparoscopic banding device (banding_device)
44 High speed video system for laryngeal imaging
45 System to study excised larynges
46 Low cost visualization to assist epidural and spinal needle placements
47 Localization of peripheral nerves
48 Minimizing magnetic interference in the MRI environment
49 Measurement device to increase the tactile feedback in regional blocks
50 Output device to increase the tactile feedback in regional blocks
51 Automatic feedback of neuromuscular stimulation in regional block
52 Wireless man-machine communication
53 IV drug project

13. Lab works

14. References

1. Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.
2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
3. Moore, J. H., Davis, C. C., and Coplan, M. A. 1989. Building Scientific Apparatus: A Practical Guide to Design and Construction. Addison-Wesley.
4. Pahl, G., Beitz, W. 1988. Engineering Design, A Systematic Approach. London, Springer-Verlag
5. Wilcox, A. 1990. Engineering Design For Electrical Engineers. Englewood Cliffs N.J., Prentice- Hall
6. Ingle, K. A. 1994. Reverse Engineering. New York, McGraw-Hill Inc
7. Carper, K. L. 1989. Forensic Engineering. New York, Elsevier
8. Middendorf, W. H. 1990. Design of Devices and Systems. New York, Marcel Dekker
9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
10. Burgess, J. 1986. Designing for Humans: The Human Factor in Engineering. Princeton, Petrocelli Books
11. Foltz, R., Penn, T. 1989. Protecting Engineering Ideas & Inventions. Cleveland OH, Penn Institute

Chairman of the Scientific and Education Council

ET4216 Biomedical Engineering Design

1. Course Title: **Biomedical Engineering Design**

2. Course ID: ET4216

3. Course Units: **1(0-2-0-4)**

- Lecture: 00 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: At least two semesters of experience with the design process

6. Requisites

- Prerequisites: -
- Corequisites: - ME3036

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley

12. Course Topics

BIOMEDICAL ENGINEERING DESIGN

Course Developer:

Some Project Titles in Biomedical Engineering

1 System for pH measurement inside incubator
2 System to monitor epilepsy in rodents
3 Device to aid communication between intubated patients and care providers
4 Measurement of pulse transit time (pulse_transit_time)
5 DSP application in medical instrumentation (TI_project)
6 Digital Braille watch (braille_watch)
7 Sensory substitution device for hearing impairment (sensory_substitution)
8 Permanently implantable inductive ICP monitor (ICP_monitor)
9 Development of an exhaled breath condensate system for use during exercise (condensate)
10 Medication adherence measurement device (medication_adherence)
11 Delivery of inhaled drugs through CPAP (cpap)
12 Device to assist in removal of pills from bubble wrapped packaging (pill_removal)
13 Leg positioner to facilitate placement of central venous catheters in the ICU
14 Physical 3D model of the larynx with moving parts (larynx_model)
15 Umbilical cord model for umbilical vein catheterization training (umbilical)
16 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
17 Assistive device to augment strength in the weak hand of a stroke patient (finger_device)
18 Motorized wheelchair mounting system (wheelchair_mount)
19 National Design Competition: Accessible Incontinence Control Device
20 Method to determine failure in embedded biomaterials (embedded_biomaterials)
21 Mechanical testing system coupled with an environmental chamber
22 Mechanical testing system coupled with an environmental chamber
23 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
24 Blinking orbital prosthesis (orbital_prosthesis)
25 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
26 Design of a heating pad for a microPET/CT scanner (heating_pad)
27 Handheld device to measure tumor size
28 Device to enhance/monitor back exercise
29 Development of optimal design for cooling patients in flight (hypothermia)
30 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device (pill_cap)
31 Device for dilating esophageal strictures (esophageal_strictures)
31 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
33 Computer mouse replacement
34 Device for the presentation of olfactory stimuli to monkeys
35 Incubation chamber for microscope (microscope)
36 Multi-IV fluid feed system
37 Mechanical testing system coupled with an environmental chamber (chamber)

38 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
39 National Design Competition: Innovations in accessible medical instrumentation
40 Artificial burning limb (burning_limb)
41 Syringe for injectable fillers (syringe)
42 Endotracheal tube securing device (endotracheal_device)
4.43 Laparoscopic banding device (banding_device)
44 High speed video system for laryngeal imaging
45 System to study excised larynges
46 Low cost visualization to assist epidural and spinal needle placements
47 Localization of peripheral nerves
48 Minimizing magnetic interference in the MRI environment
49 Measurement device to increase the tactile feedback in regional blocks
50 Output device to increase the tactile feedback in regional blocks
51 Automatic feedback of neuromuscular stimulation in regional block
52 Wireless man-machine communication
53 IV drug project

13. Lab works

14. References

1. Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.
2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
3. Moore, J. H., Davis, C. C., and Coplan, M. A. 1989. Building Scientific Apparatus: A Practical Guide to Design and Construction. Addison-Wesley.
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9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
10. Burgess, J. 1986. Designing for Humans: The Human Factor in Engineering. Princeton, Petrocelli Books
11. Foltz, R., Penn, T. 1989. Protecting Engineering Ideas & Inventions. Cleveland OH, Penn Institute

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ET4218 Biomedical Engineering Design

1. Course Title: **Biomedical Engineering Design**

2. Course ID: ET4218

3. Course Units: **1(0-2-0-4)**

- Lecture: 00 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: At least two semesters of experience with the design process

6. Requisites

- Prerequisites: -
- Corequisites: - MSE3026

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley

12. Course Topics

BIOMEDICAL ENGINEERING DESIGN

Course Developer:

Some Project Titles in Biomedical Engineering

1 System for pH measurement inside incubator
2 System to monitor epilepsy in rodents
3 Device to aid communication between intubated patients and care providers
4 Measurement of pulse transit time (pulse_transit_time)
5 DSP application in medical instrumentation (TI_project)
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13 Leg positioner to facilitate placement of central venous catheters in the ICU
14 Physical 3D model of the larynx with moving parts (larynx_model)
15 Umbilical cord model for umbilical vein catheterization training (umbilical)
16 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
17 Assistive device to augment strength in the weak hand of a stroke patient (finger_device)
18 Motorized wheelchair mounting system (wheelchair_mount)
19 National Design Competition: Accessible Incontinence Control Device
20 Method to determine failure in embedded biomaterials (embedded_biomaterials)
21 Mechanical testing system coupled with an environmental chamber
22 Mechanical testing system coupled with an environmental chamber
23 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
24 Blinking orbital prosthesis (orbital_prosthesis)
25 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
26 Design of a heating pad for a microPET/CT scanner (heating_pad)
27 Handheld device to measure tumor size
28 Device to enhance/monitor back exercise
29 Development of optimal design for cooling patients in flight (hypothermia)
30 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device (pill_cap)
31 Device for dilating esophageal strictures (esophageal_strictures)
31 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
33 Computer mouse replacement
34 Device for the presentation of olfactory stimuli to monkeys
35 Incubation chamber for microscope (microscope)
36 Multi-IV fluid feed system
37 Mechanical testing system coupled with an environmental chamber (chamber)

38 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
39 National Design Competition: Innovations in accessible medical instrumentation
40 Artificial burning limb (burning_limb)
41 Syringe for injectable fillers (syringe)
42 Endotracheal tube securing device (endotracheal_device)
4.43 Laparoscopic banding device (banding_device)
44 High speed video system for laryngeal imaging
45 System to study excised larynges
46 Low cost visualization to assist epidural and spinal needle placements
47 Localization of peripheral nerves
48 Minimizing magnetic interference in the MRI environment
49 Measurement device to increase the tactile feedback in regional blocks
50 Output device to increase the tactile feedback in regional blocks
51 Automatic feedback of neuromuscular stimulation in regional block
52 Wireless man-machine communication
53 IV drug project

13. Lab works

14. References

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2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
3. Moore, J. H., Davis, C. C., and Coplan, M. A. 1989. Building Scientific Apparatus: A Practical Guide to Design and Construction. Addison-Wesley.
4. Pahl, G., Beitz, W. 1988. Engineering Design, A Systematic Approach. London, Springer-Verlag
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7. Carper, K. L. 1989. Forensic Engineering. New York, Elsevier
8. Middendorf, W. H. 1990. Design of Devices and Systems. New York, Marcel Dekker
9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
10. Burgess, J. 1986. Designing for Humans: The Human Factor in Engineering. Princeton, Petrocelli Books
11. Foltz, R., Penn, T. 1989. Protecting Engineering Ideas & Inventions. Cleveland OH, Penn Institute

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ET4236 Introduction to Computer Networks

1. Course Title: **Introduction to Computer Networks**

2. Course ID: ET4236

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:.

6. Requisites

- Prerequisites: -
- Corequisites: - ET4276

7. Objectives and Expected Outcomes

- This course is an introduction to computer networks and is suitable for undergraduates and beginning graduate students. The course will investigate computer networks and network protocols from both a conceptual and a design standpoint. The primary focus of the course will be on the architecture, protocols and software used in networks that comprise the Internet.

8. Description

Architecture of computer networks and network protocols, protocol layering, reliable transmission, congestion control, flow control, naming and addressing, unicast and multicast routing, network security, network performance widely used protocols such as Ethernet, wireless LANs, IP, TCP, and Http

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 15%
- Projects: 40%
- Mid-term: 20%
- Final exam: 25%

11. Course Materials

- "*Computer Networks: A Systems Approach*" *3rd Edition* – Larry Peterson, Bruce Davie – Morgan-Kaufmann, ISBN: 1-55860-832-X.

12. Course Topics

INTRODUCTION TO COMPUTER NETWORKS

Course Developer:

Chapter 1: FOUNDATION

- 1.1 Applications
- 1.2 Requirements
  - 1.2.1 Connectivity
  - 1.2.2 Cost-Effective Resource Sharing
  - 1.2.3 Support for Common Services
- 1.3 Network Architecture
  - 1.3.1 Layering and Protocols
  - 1.3.2 OSI Architecture
  - 1.3.3 Internet Architecture
- 1.4 Implementing Network Software
  - 1.4.1 Application Programming Interface (Sockets)
  - 1.4.2 Example Application
  - 1.4.3 Protocol Implementation Issues
- 1.5 Performance
  - 1.5.1 Bandwidth and Latency
  - 1.5.2 Delay × Bandwidth Product
  - 1.5.3 High-Speed Networks
  - 1.5.4 Application Performance Needs

Chapter 2: DIRECT LINK NETWORK

- 2.1 Hardware Building Blocks
  - 2.1.1 Nodes
  - 2.1.2 Links
- 2.2 Encoding (NRZ, NRZI, Manchester, 4B/5B)
- 2.3 Framing
  - 2.3.1 Byte-Oriented Protocols (PPP)
  - 2.3.2 Bit-Oriented Protocols (HDLC)
  - 2.3.3 Clock-Based Framing (SONET)
- 2.4 Error Detection
  - 2.4.1 Two-Dimensional Parity
  - 2.4.2 Internet Checksum Algorithm
  - 2.4.3 Cyclic Redundancy Check
- 2.5 Reliable Transmission
  - 2.5.1 Stop-and-Wait
  - 2.5.2 Sliding Window
  - 2.5.3 Concurrent Logical Channels
- 2.6 Ethernet (802.3)
  - 2.6.1 Physical Properties
  - 2.6.2 Access Protocol

2.6.3 Experience with Ethernet
2.7 Rings (802.5, FDDI, RPR)
2.7.1 Token Ring Media Access Control
2.7.2 Token Ring Maintenance
2.7.3 FDDI
2.7.4 Resilient Packet Ring (802.17)

Chapter 3: PACKET SWITCHING
3.1 Switching and Forwarding
3.1.1 Datagrams
3.1.2 Virtual Circuit Switching
3.1.3 Source Routing
3.2 Bridges and LAN Switches
3.2.1 Learning Bridges
3.2.2 Spanning Tree Algorithm
3.2.3 Broadcast and Multicast
3.2.4 Limitations of Bridges
3.3 Implementation and Performance
3.3.1 Ports
3.3.2 Fabrics

Chapter 4: INTERNETWORKING
4.1 Simple Internetworking (IP)
4.1.1 What Is an Internetwork?
4.1.2 Service Model
4.1.3 Global Addresses
4.1.4 Datagram Forwarding in IP
4.1.5 Address Translation (ARP)
4.1.6 Host Configuration (DHCP)
4.1.7 Error Reporting (ICMP)
4.1.8 Virtual Networks and Tunnels
4.2 Routing
4.2.1 Network as a Graph
4.2.2 Distance Vector (RIP)
4.2.3 Link State (OSPF)
4.2.4 Metrics
4.2.5 Routing for Mobile Hosts
4.2.6 Router Implementation
4.3 Global Internet
4.3.1 Subnetting
4.3.2 Classless Routing (CIDR)
4.3.3 Interdomain Routing (BGP)
4.3.4 Routing Areas
4.3.5 IP Version 6 (IPv6)
4.4 Multicast

4.4.1 Multicast Addresses
4.4.2 Multicast Routing (DVMRP, PIM, MSDP)

Chapter 5: END-TO-END PROTOCOLS
5.1 Simple Demultiplexer (UDP)
5.2 Reliable Byte Stream (TCP)
5.2.1 End-to-End Issues
5.2.2 Segment Format
5.2.3 Connection Establishment and Termination
5.2.4 Sliding Window Revisited
5.2.5 Triggering Transmission
5.2.6 Adaptive Retransmission
5.2.7 Record Boundaries
5.2.8 TCP Extensions
5.2.9 Alternative Design Choices
5.3 Remote Procedure Call
5.3.1 RPC Fundamentals
5.3.2 RPC Implementations (SunRPC, DCE)
5.4 Transport for Real-Time Applications (RTP)
5.4.1 Requirements
5.4.2 RTP Details
5.4.3 Control Protocol
5.5 Performance

Chapter 6: CONGESTION CONTROL AND RESOURCE ALLOCATION
6.1 Issues in Resource Allocation
6.1.1 Network Model
6.1.2 Taxonomy
6.1.3 Evaluation Criteria
6.2 Queuing Disciplines
6.2.1 FIFO
6.2.2 Fair Queuing
6.3 TCP Congestion Control
6.3.1 Additive Increase/Multiplicative Decrease
6.3.2 Slow Start
6.3.3 Fast Retransmit and Fast Recovery
6.4 Congestion-Avoidance Mechanisms
6.4.1 DECbit
6.4.2 Random Early Detection (RED)
6.4.3 Source-Based Congestion Avoidance
6.5 Quality of Service
6.5.1 Application Requirements
6.5.2 Integrated Services (RSVP)
6.5.3 Differentiated Services (EF, AF)
6.5.4 Equation-Based Congestion Control

Chapter 7: APPLICATIONS

- 7.1 Traditional Applications
  - 7.1.1 Electronic Mail (SMTP, MIME, IMAP)
  - 7.1.2 World Wide Web (HTTP)
  - 7.1.3 Name Service (DNS)
  - 7.1.4 Network Management (SNMP)
- 7.2 Web Services
  - 7.2.1 Custom Application Protocols (WSDL, SOAP)
  - 7.2.2 A Generic Application Protocol (REST)
- 7.3 Multimedia Applications
  - 7.3.1 Session Control and Call Control (SDP, SIP, H.323)
  - 7.3.2 Resource Allocation for Multimedia Applications
- 7.4 Other Networks
  - 7.4.1 Wireless Networks
  - 7.4.1 Sensor and Ad Hoc Networks
  - 7.4.3 Peer-to-Peer Networks (Gnutella, BitTorrent)

Chapter 8: NETWORK SECURITY

- 8.1 Cryptographic Tools
  - 8.1.1 Principles of Ciphers
  - 8.1.2 Symmetric-Key Ciphers
  - 8.1.3 Public-Key Ciphers
  - 8.1.4 Authenticators
- 8.2 Key Predistribution
  - 8.2.1 Predistribution of Public Keys
  - 8.2.2 Predistribution of Symmetric Keys
- 8.3 Authentication Protocols
  - 8.3.1 Originality and Timeliness Techniques
  - 8.3.2 Public-Key Authentication Protocols
  - 8.3.3 Symmetric-Key Authentication Protocols
  - 8.3.4 Diffie-Hellman Key Agreement
- 8.4 Secure Systems
  - 8.4.1 Pretty Good Privacy (PGP)
  - 8.4.2 Secure Shell (SSH)
  - 8.4.3 Transport Layer Security (TLS, SSL, HTTPS)
  - 8.4.4 IP Security (IPsec)
  - 8.4.5 Wireless Security (802.11i)
- 8.5 Firewalls
- 8.6 Denial-of-Service Attacks

13. Lab works

14. References

1. "*Computer Networks: A Systems Approach*" *3rd Edition* – Larry Peterson, Bruce Davie – Morgan-Kaufmann, ISBN: 1-55860-832-X.
2. "*Computer Networking: A Top-Down Approach Featuring the Internet" 3rd Edition* – James F. Kurose, Keith W. Ross –Addison Wesley, ISBN: 0321227352
3. *"UNIX Network Programming, Volume 1: Networking APIs - Sockets and XTI"* – W. Richard Stevens – Prentice Hall, 1998, ISBN: 0-13-490012-X
4. *"Computer Networks" 4th Edition* – Andrew S. Tanenbaum – Prentice Hall, ISBN: 978-0130661029
5. "*Computer Networks: Principles, Technologies and Protocols for Network Design"* – Natalia Olifer, Victor Olifer – Wiley, ISBN: 978-0470869826
6. *"Data Communications, Computer Networks, and Open Systems" 4th Edition* – F. Halsall – Addison Wesley, ISBN: 978-0201422931

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ET4276 Introduction to Computer Architecture

1. Course Title: **Introduction to Computer Architecture**

2. Course ID: ET4276

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Logic design and Boolean algebra. Assembly language programming. Ability to use design tools available on computer.

6. Requisites

- Prerequisites: - ET3066
- Corequisites: -

7. Objectives and Expected Outcomes

- It is expected that students at the end of this course will be able to design a stored program computer using logic gates, flip-flops, and components from a given library of digital components.

8. Description

The design of computer systems and components. Processor design, instruction set design, and addressing; control structures and microprogramming; memory management, caches, and memory hierarchies; and interrupts and I/O structures

9. Student Duties

- Class attendance: ≥ 80%
- Homework:
- Lab

10. Assessment

- Homeworks: 20%
- Projects: 20%
- Mid-term: 30%
- Final exam: 30%

11. Course Materials

- *"Computer Organization and Design: The Hardware/Software Interface" 3nd Edition* – David A. Patterson, John L. Hennessy – Morgan Kaufmann, ISBN: 978-1558606043

12. Course Topics

INTRODUCTION TO COMPUTER ARCHITECTURE

Course Developer:

Chapter 1: Computer Abstractions and Technology

1.1 Introduction
1.2 Below your program
1.3 Under the Cover
1.4 Real Stuff: Manufacturing Pentium 4 Chip
1.5 Fallacies and Pitfalls
1.6 Concluding Remarks
1.7 Historical Perspective and Further Readings
1.8 Excersices

Chapter 2: Instructions: Languages of the Machine

2.1 Introduction
2.2 Operations of the Computer Hardware
2.3 Operands of the Computer Hardware
2.4 Representing Instructions in the Computer
2.5 Logical Operations
2.6 Instructions for Making Decisions
2.7 Supporting Procedures in Computer Hardware
2.8 Communicating with People
2.9 MIPS Addressing for 32-bit Immediates and Addresses
2.10 Translating and Starting a Program
2.11 How Compilers Optimize
2.12 How Compilers Work: An Introduction
2.13 A C Sort Example to Put It All Together
2.14 Implementing an Object-Oriented Language
2.15 Arrays versus Pointers
2.16 Real Stuff: IA-32 Instructions
2.17 Fallacies and Pitfalls
1.9 2.18 Excersices

Chapter 3: Arithmetic for Computers

3.1 Introduction
3.2 Signed and Unsigned Numbers
3.3 Addition and Subtraction
3.4 Multiplication
3.5 Division
3.6 Floating Point
3.7 Real Stuff: Floating Point in the IA-32
3.8 Fallacies and Pitfalls
3.9 Concluding Remarks
3.10 Excersices

Chapter 4: The Processor: Datapath and Control

4.1 Introduction
4.2 Logic Design Conventions
4.3 Building a Datapath
4.4 A Simple Implementation Scheme
4.5 Excersices

Chapter 5: Enhencing Performance with Pipeline

5.1 An Overview of Pipeline
5.2 A Pipelined Datapath
5.3 Pipelined Control
5.4 Data Hazards and Forwarding
5.5 Data Hazards and Stalls
5.6 Branch Hazards
5.7 Using a Hardware Description Language to Describe and Model a Pipeline
5.8 Exceptions
5.9 Avanced Pipelining: Extracting More Performance
5.10 Real Stuff: The Pentium 4 Pipeline
5.11 Excersices

Chapter 6: Large and Fast: Exploiting Memory Hierarchy

6.1 Introduction
6.2 The Basics of Caches
6.3 Measuring and Improving Cache Performance
6.4 Virual Memory
6.5 A Common Framework for Memory Hierarchies
6.6 Real Stuff: The Pentium P4 and the AMD Opteron Memory Hierarchies
6.7 Excersices

Chapter 7: Storage, Networks and Other Peripherals

7.1 Introduction
7.2 Disk Storage and Dependability
7.3 Networks
7.4 Buses and Other Connections between Processors, Memory and I/O Devices
7.5 Interfacing I/O Devices to the Processors, Memory and Operating System
7.6 I/O Performance Measures: Examples from Disk and File Systems
7.7 Design an I/O System
7.8 Real Stuff: A Digital Camera
7.9 Fallacies and Pitfalls
7.10 Concluding Remarks
7.11 Historical Perspective and Further Readings
7.12 Excersices

13. Lab works

14. References

1. "*Computer Organization and Design: The Hardware/Software Interface" 3rd Edition* – David A. Patterson, John L. Hennessy – Morgan Kaufmann, ISBN: 978-1558606043
2. "*Computer Organization and Design Fundamentals"* – David L. Tarnoff – David Tarnoff & Lulu.com, ISBN: 978-1411636903
3. "*Computer Organization" 5th Edition* – Carl Hamacher, Zvonko Vranesic, Safwat Zaky – McGraw-Hill, ISBN: 978-0072320862
4. "*Structured Computer Organization" 5th Edition* – Andrew S. Tanenbaum – Prentice Hall, ISBN: 978-0131485211
5. "*Computer Organization and Architecture: Designing for Performance" 7th Edition* – William Stallings – Prentice Hall, ISBN: 978-0131856448

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ET4456 Human Physiology and Anatomy

1. Course Title: **Human Physiology and Anatomy**

2. Course ID: ET4456

3. Course Units: **5(3-1-1-10)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Biol or zool & gen chem before enroll

6. Requisites

- Prerequisites: - PH1026, MI1026

7. Objectives and Expected Outcomes

Physiology is one of the most fascinating and relevant of all college subjects. In this one-semester course you will study all of the major systems of the human body, so that you can develop a broad, integrated understanding of function from the cellular to the organ-system level. This information is essential foundation for students from a wide variety of basic science and pre-clinical majors, including: Nursing, Pharmacy, Biology, Kinesiology, Biomedical Engineering, Dietetics, Biochemistry, Physician Assistant, Zoology, and many others. But Physiology is far more than just an academic prerequisite. It is an instruction manual for your body! Each one of us faces a *lifetime* of decisions about things affecting our health and happiness: eating, dieting, dietary supplements, exercise, illness, accidents, surgery, over-the-counter medications, prescription medications, recreational drugs, aging, and dying. An understanding of physiology will help you make good, informed decisions, and protect you from the clamor of marketers who care more about getting your dollars than about your health and happiness. Regardless of whether you are taking Physiology to prepare for a healthcare career or simply indulging your curiosity about how your body works, we're certain you'll learn something useful!

8. Description

Lectures, recitations, demonstrations, and labs

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Labs: 20%
- Mid-terms: 50%
- Final exam: 30%

11. Course Materials

- *"Human Physiology: The Mechanisms of Body Function" 11th Edition* – Eric P. Widmaier, Hershel Raff, Kevin T. Strang – McGraw-Hill, ISBN: 978-0077216092

12. Course Topics

HUMAN PHYSIOLOGY AND ANATOMY

Course Developer:

Chapter 1. Homeostasis: A Framework for Human Physiology

1.1 The Scope of Human Physiology

1.2 How Is the Body Organized?

- 1.2.1 Cells: The Basic Units of Living Organisms
- 1.2.2 Tissues
- 1.2.3 Organs and Organ Systems

1.3 Body Fluid Compartments

1.4 Homeostasis: A Defining Feature of Physiology

1.5 General Characteristics of Homeostatic Control Systems

- 1.5.1 Feedback Systems
- 1.5.2 Resetting of Set Points
- 1.5.3 Feedforward Regulation

1.6 Components of Homeostatic Control Systems

- 1.6.1 Reflexes
- 1.6.2 Local Homeostatic Responses

1.7 Intercellular Chemical Messengers

1.8 Processes Related to Homeostasis

- 1.8.1 Adaptation and Acclimatization
- 1.8.2 Biological Rhythms

Balance in the Homeostasis of Chemical Substances in the Body

Chapter 2. Cellular Structure, Proteins, and Metabolism

2.1 Cell Structure

- 2.1.1 Membranes
- 2.1.2 Cell Organelles

2.2 Proteins

- 2.2.1 Genetic Code
- 2.2.2 Protein Synthesis
- 2.2.3 Protein Degradation
- 2.2.4 Protein Secretion

2.3 Metabolic Pathways

- 2.3.1 Cellular Energy Transfer
- 2.3.2. Carbohydrate, Fat, and Protein Metabolism
- 2.3.3 Essential Nutrients

Chapter 3. Movement of Molecules Across Cell Membranes

3.1 Diffusion

- 3.1.1 Magnitude and Direction of Diffusion
- 3.1.2 Diffusion Rate Versus Distance
- 3.1.3 Diffusion Through Membranes

3.2 Mediated-Transport Systems

- 3.2.1 Facilitated Diffusion

3.2.2 Active Transport
3.3 Osmosis
3.4 Endocytosis and Exocytosis
3.4.1 Endocytosis
3.4.2 Exocytosis
3.5 Epithelial Transport

Chapter 4. Neuronal Signaling and the Structure of the Nervous System
4.1 Neural Tissue
4.1.1 Structure and Maintenance of Neurons
4.1.2 Functional Classes of Neurons
4.1.3 Glial Cells
4.1.4 Neural Growth and Regeneration
4.2 Structure of the Nervous System
4.2.1 Central Nervous System: Brain
4.2.2 Central Nervous System: Spinal Cord
4.2.3 Peripheral Nervous System
4.2.4 Autonomic Nervous System
4.2.5 Blood Supply, Blood-Brain Barrier, and Cerebrospinal Fluid
4.3 Sensory Receptors
4.4 Specific Sensory Systems
4.4.1 Somatic Sensation
4.4.2 Vision
4.4.3 Hearing
4.4.4. Vestibular System
4.4.5 Chemical Senses
4.5 Consciousness, the Brain, and Behavior
4.5.1 States of Consciousness
4.5 2 Conscious Experiences
4.5.3 Motivation and Emotion
4.5.4 Learning and Memory
4.5.5 Cerebral Dominance and Language

Chapter 5. Muscle
5.1 Skeletal Muscle
5.1.1 Structure
5.1.2 Molecular Mechanisms of Skeletal Muscle Contraction
5.1.3 Mechanics of Single-Fiber Contraction
5.1.4 Skeletal Muscle Energy Metabolism
5.1.5 Types of Skeletal Muscle Fibers
5.1.6 Whole-Muscle Contraction
5.2 Smooth and Cardiac Muscle
5.2.1 Structure of Smooth Muscle
5.2.2 Smooth Muscle Contraction and Its Control
5.2.3 Cardiac Muscle

Chapter 6. The Endocrine System
6.1 Principles of Hormonal Control Systems
6.1.1 Hormone Structures and Synthesis
6.1.2 Hormone Transport in the Blood
6.1.3 Hormone Metabolism and Excretion
6.1.4 Mechanisms of Hormone Action
6.1.5 Inputs that Control Hormone Secretion
6.1.6 Types of Endocrine Disorders
6.2 The Hypothalamus and Pituitary Gland
6.2.1 Control Systems Involving the Hypothalamus and Pituitary
6.2.2 Posterior Pituitary Hormones
6.2.3 Anterior Pituitary Hormones and the Hypothalamus
6.3 The Thyroid Gland
6.3.1 Synthesis of Thyroid Hormones
6.3.2 Control of Thyroid Function
6.3.3 Actions of Thyroid Hormones
6.4 Endocrine Control of Growth
6.4.1 Bone Growth
6.4.2 Environmental Factors Influencing Growth
6.4.3 Hormonal Influences on Growth
6.5 Endocrine Control of Ca2+ Homeostasis
6.5.1 Effector Sites for Calcium Homeostasis
6.5.2 Hormonal Controls
6.5.3 Metabolic Bone Diseases

Chapter 7. Cardiovascular Physiology
7.1 Overall Design of the Circulatory System
7.1.1 System Overview
7.1.2 Pressure, Flow, and Resistance
7.2 The Heart
7.2.1 Anatomy
7.2.2 Heartbeat Coordination
7.2.3 Mechanical Events of the Cardiac Cycle
7.2.4 The Cardiac Output
7.2.5 Measurement of Cardiac Function
7.3 The Vascular System
7.3.1 Arteries
7.3.2 Arterioles
7.3.3 Capillaries
7.3.4 Veins
7.3.5 The Lymphatic System
7.4 Blood and Hemostasis
7.4.1 Plasma
7.4.2 The Blood Cells

7.4.3 Hemostasis: The Prevention of Blood Loss

Chapter 8. Respiratory Physiology
8.1 Organization of the Respiratory System
8.1.1 The Airways and Blood Vessels
8.1.2 Site of Gas Exchange: The Alveoli
8.1.3 Relation of the Lungs to the Thoracic (Chest) Wall
8.2 Ventilation and Lung Mechanics
8.2.1 How Is a Stable Balance Achieved Between Breaths?
8.2.2 Inspiration
8.2.3 Expiration
8.2.4 Lung Compliance
8.2.5 Airway Resistance
8.2.6 Lung Volumes and Capacities
8.2.7 Alveolar Ventilation
8.3 Exchange of Gases in Alveoli and Tissues
8.3.1 Partial Pressures of Gases
8.3.2 Alveolar Gas Pressures
8.3.3 Gas Exchange Between Alveoli and Blood
8.3.4 Matching of Ventilation and Blood Flow in Alveoli
8.3.5 Gas Exchange Between Tissues and Blood
8.4 Transport of Oxygen in Blood
8.4.1 What Is the Effect of PO2 on Hemoglobin Saturation?
8.4.2 Effects of Blood PCO2, H+ Concentration, Temperature, and DPG Concentration on Hemoglobin Saturation
8.5 Transport of Carbon Dioxide in Blood
8.6 Transport of Hydrogen Ions Between Tissues and Lungs
8.7 Control of Respiration
8.8 Nonrespiratory Functions of the Lungs

Chapter 9. The Kidneys and Regulation of Water and Inorganic Ions
9.1 Basic Principles of Renal Physiology
9.1.1 Renal Functions
9.1.2 Structure of the Kidneys and Urinary System
9.1.3 Basic Renal Processes
9.1.4 The Concept of Renal Clearance
9.1.5 Micturition
9.2 Regulation of Ion and Water Balance
9.2.1 Total-Body Balance of Sodium and Water
9.2.2 Basic Renal Processes for Sodium and Water
9.2.3 Renal Sodium Regulation
9.2.4 Renal Water Regulation
9.2.5 Potassium Regulation
9.2.6 Renal Regulation of Calcium and Phosphate
9.3 Hydrogen Ion Regulation

9.3.1 Sources of Hydrogen Ion Gain or Loss
9.3.2 Buffering of Hydrogen Ions in the Body
9.3.3. Integration of Homeostatic Controls
9.3.4 Renal Mechanisms
9.3.5 Classification of Acidosis and Alkalosis

Chapter 10. The Digestion and Absorption of Food
10.1 Functions of the Gastrointestinal Organs
10.2 Structure of the Gastrointestinal Tract Wall
10.3 Digestion and Absorption
10.3.1 Carbohydrate
10.3.2 Protein
10.3.3 Fat
10.3.4 Vitamins
10.3.5 Water and Minerals
10.4 How Are Gastrointestinal Processes Regulated?
10.4.1 Basic Principles
10.4.2 Mouth, Pharynx, and Esophagus
10.4.3 Stomach
10.4 4 Pancreatic Secretions
10.4.5 Bile Secretion and Liver Function
10.4.6 Small Intestine
10.4.7 Large Intestine

Chapter 11. Reproduction
11.1 General Terminology and Concepts; Sex Determination and Differentiation
11.1.1 General Principles of Gametogenesis
11.1.2 Sex Determination
11.1.3 Sex Differentiation
11.1.4 Sexual Differentiation of the Central Nervous System and Homosexuality
11.2 Male Reproductive Physiology
11.2.1 Anatomy
11.2 2 Spermatogenesis
11.2.3 Transport of Sperm
11.2.4 Hormonal Control of Male Reproductive Functions
11.2.5 Puberty
11.2.6 Andropause
11.3 Female Reproductive Physiology
11.3.1 Anatomy
11.3.2 Ovarian Functions
11.3.4 Control of Ovarian Function
11.3.5 Uterine Changes in the Menstrual Cycle
11.3.6 Other Effects of Estrogen and Progesterone
11.3.7 Androgens in Women
11.3.8 Puberty

11.3.9 Female Sexual Response
11.3.10 Pregnancy
11.3.11 Menopause

Chapter 12. Regulation of Organic Metabolism and Energy Balance

12.1 Control and Integration of Carbohydrate, Protein, and Fat Metabolism
12.1.1 Events of the Absorptive and Postabsorptive States
12.1.2 Endocrine and Neural Control of the Absorptive and Postabsorptive States
12.1.3 Energy Homeostasis in Exercise and Stress
12.2 Regulation of Total-Body Energy Balance and Temperature
12.2.1 Basic Concepts of Energy Expenditure
12.2.2 Regulation of Total-Body Energy Stores
12.2.3 Regulation of Body Temperature

Chapter 13. Defense Mechanisms of the Body

13.1 Cells Mediating Immune Defenses
13.2 Nonspecific Immune Defenses
13.2.1 Defenses at Body Surfaces
13.2.2 Inflammation
13.2.3 Interferons
13.3 Specific Immune Defenses
13.3.1 Overview
13.3.2 Lymphoid Organs and Lymphocyte Origins
13.3.3 Functions of B Cells and T Cells
13.3.4 Lymphocyte Receptors
13.3.5 Antigen Presentation to T Cells
13.3.6 NK Cells
13.3.7 Development of Immune Tolerance
13.3.8 Antibody-Mediated Immune Responses: Defenses Against Bacteria, Extracellular Viruses, and Toxins
13.3.9 Defenses Against Virus-Infected Cells and Cancer Cells

13. Lab works

14. References

1. *"Human Physiology: The Mechanisms of Body Function" 11th Edition* – Eric P. Widmaier, Hershel Raff, Kevin T. Strang – McGraw-Hill, ISBN: 978-0077216092
2. *"Human Anatomy & Physiology" 7th Edition* - Elaine N. Marieb, Katja N. Hoehn – Benjamin Cummings, ISBN: 978-0805359091
3. *"Texbook of medical physiology" 11th Edition*, Arthur C. Guyton, John E. Hall – Saunders, ISBN: 978-0721602400
4. *"Principles of Anatomy and Physiology" – 11th Edition* - Gerard J. Tortora, Bryan H. Derrickson – John Wiley & Sons, ISBN: 978-0471689348

5. *“Anatomy & Physiology: The Unity of Form and Function” 4th Edition* - Kenneth S. Saladin – McGraw-Hill, ISBN: 978-0073316086
6. *“Review of Medical Physiology”* 22nd Edition – William F. Ganong – McGraw-Hill, ISBN: 978-0071440400

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ET4466 Measurements and Instrumentation

1. Course Title: **Measurements and Instrumentation**

2. Course ID: ET4466

3. Course Units: **4(3-1-1-8)**

- Lecture: 45 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:

6. Requisites

- Prerequisites: - PH1026

7. Objectives and Expected Outcomes

Principles of instrumentation and measurement systems, analysis of experimental data, electronic components, instrumentation for measuring various parameters of biological systems (temperature, force, flow)

8. Description

Principles of instrumentation and measurement systems, analysis of experimental data, electronic components, instrumentation for measuring various parameters of biological systems (temperature, force, flow)

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Labs: 20%
- Projects: 20%
- Mid-terms: 30%
- Final exam: 30%

11. Course Materials

- "*Biomedical Transducers and Instruments*" – Tatsuo Togawa, Toshiyo Tamura, P.A. Öberg – CRC Press, ISBN: 978-0849376719

12. Course Topics

MEASUREMENTS AND INSTRUMENTATION

Course Developer:

Chapter 1. Introduction

1.1 Introduction
1.2 Definition of Terms
1.3 Calibration
1.4 Standards
1.5 Dimensions and Units
1.6 The Generalized Measurement System

Chapter 2. Fundamental Concepts

2.1 Signals and Noise in the Measurements
- 2.1.1 Measurement
- 2.1.2 Signals and Noise
- 2.1.3 Amplitude and Power
- 2.1.4 Signal-to-Noise Ratio
- 2.1.5 Different Types of Noise

2.2 Characteristics of the Measurement Systems
- 2.2.1 Sensors/Transducers and Measurement Systems
- 2.2.2 Static Characteristics
- 2.2.3 Dynamic Characteristics
- 2.2.4 Enviromental Characteristics

2.3 Determination of Absolute Quantity
- 2.3.1 Accuracy and Error
- 2.3.2 Types of Error

Chapter 3. Analysis of Measurement Data

3.1 Introduction
3.2 Error Analysis on a Commonsense Basis
3.3 Uncertainty Analysis
3.4 Evaluation of Uncertainties for Complicated Data Reduction
3.5 Statistical Analysis of Experimental Data
3.6 The Gaussian or Normal Error Distribution
3.7 Comparison of Data with Normal Distribution
3.8 The Chi-Square Test of Goodness of Fit
3.9 Method of Least Squares
3.10 The Correlation Coefficient
3.11 Multivariable Regression
3.12 Standard Deviation of the Mean
3.13 Student's *t*-Distribution
3.14 Graphical Analysis and Curve Fitting
3.15 Choice of Graph Formats
3.16 General Considerations in Data Analysis

Chapter 4. Basic Transducers

4.1 Transducers
4.2 The Variable-Resistance Transducer
4.3 The Differential Transformer (LVDT)
4.4 Capacitive Transducers
4.5 Piezoelectric Transducers
4.6 Photoelectric Effects
4.7 Photoconductive Transducers
4.8 Photovoltaic Cells
4.9 Ionization Transducers
4.10 Magnetometer Search Coil
4.11 Hall-Effect Transducers
4.12 Seebeck-Effect Transducers

Chapter 5. Pressure Measurement

5.1 Object Quantities
    5.1.1 Units of Pressure
    5.1.2 Requirements for Pressure Measurement
5.2 Direct Pressure Measurement
    5.2.1 Catheters and the Diaphragm-Type Pressure Transducer
    5.2.2 Dynamic Response of Catheter-Transducer System
    5.2.3 Catheter-Tip Pressure Transducer
    5.2.4 Pressure Measurements in Small Vessels
    5.2.5 Differential Pressure Measurement
5.3 Indirect Pressure Measurement
    5.3.1 Indirect Measurements of Systolic, Diastolic and Mean Blood Pressure
    5.3.2 Indirect Measurements of Instantaneous Aterial Pressure
    5.3.3 Internal Pressure Measurements by Reaction Forces

Chapter 6. Flow Measurement

6.1 Object Quantities
    6.1.1 Units of Flow Measurements
    6.1.2 Requirements for Measurement Ranges
6.2 Flow Measurements in Single Vessels
    6.2.1 Electromagnetic Flowmeters
    6.2.2 Ultrasound Flowmeters
    6.2.3 Indicator Dilution Methods
    6.2.4 Heat Dissipation Method
    6.2.5 Laser-Doppler Method
    6.2.6 Correlation Methods
    6.2.7 Mechanical Flowmeters
6.3 Tissue Blood Flow Measurement
    6.3.1 Venous Occlusion Plesthymography
    6.3.2 Clearance Technique
    6.3.3 Heat Transport Techique

6.3.4 Laser-Doppler Technique
6.4 Respiratory Gas Flow Measurement
6.4.1 Gas Flow Sensors
6.4.2 Volume-Measuring Spirometers
6.4.3 Lung Plesthymography

Chapter 7. Motion and Force Measurement
7.1 Object Quantities
7.1.1 Units of Quantities
7.1.2 Objects of Measurement
7.1.3 Coordinate Systems
7.2 Motion Measurements
7.2.1 Displacement and Rotation Measurements by Contact Transducers
7.2.2 Noncontact Measurements of Displacement and Rotation
7.2.3 Linear and Angular Velocity Measurements
7.2.4 Translational and Angular Acceleration Measurements
7.3 Force Measurements
7.3.1 Muscle Constraction Measurements
7.3.2 Measurements of Stresses and Strain
7.3.3 Ground Force Measurements

Chapter 8. Temperature, Heat Flow and Evaporation Measurement
8.1 Object Quantities
8.1.1 Units of Thermal Quantities
8.1.2 Requirements for Measurement Ranges
8.2 Temperature Transducers
8.2.1 Thermistors
8.2.2 Thermocouples
8.2.3 Thermoresistive Elements
8.2.4 p-n Junction Diodes and Transistors
8.2.5 Crystal Resonators
8.3 Noncontact Temperature Measurementss
8.3.1 Infrared Measurements
8.3.2 Microwave Measurements
8.4 Contact Temperature Measurements
8.5 Heat Flow Measurements
8.5.1 Heat Flow Transducers
8.5.2 Direct Calorimeters
8.6 Evaporation Measurements

Chapter 9. Chemical Measurements
9.1 Object Quantities
9.1.1 Units of Chemical Quantities
9.1.2 Objects of Chemical Measurements
9.1.3 Requirements and Limitations in Chemical Measurements

9.2 Chemical Transducers
- 9.2.1 Electrochemical Transducers
- 9.2.2 Optical-Based Chemical Transducers
- 9.2.3 Acoustic and Thermal-Based Chemical Transducers
- 9.2.4 Biosensors
- 9.2.5 Instrumental Analysis

9.3 Continuos Measurement of Chemical Quantities
- 9.3.1 Measurement by Indwelling Transducers
- 9.3.2 Ex Vivo Measurements and Measurements by Microdialysis
- 9.3.3 Transcutaneous Measurements

13. Lab works

14. References

1. **"***Biomedical Transducers and Instruments***"** – Tatsuo Togawa, Toshiyo Tamura, P.A. Öberg – CRC Press, ISBN: 978-0849376719
2. *"Experimental Methods for Engineers" 7th Edition* – Jack P. Holman – McGraw-Hill, ISBN: 978-0073660554
3. *"Sensors in Biomedical Applications: Fundamentals, Technology and Applications"* – Gabor Harsanyi – CRC Press, ISBN: 978-1566768856
4. *"Modern Sensors Handbook"* – Pavel Ripka and Alois Tipek – ISTE Publishing Company, ISBN: 978-1905209668
5. *"Biomeasurement: Understanding, Analysing, and Communicating Data in the Biosciences"* – Dawn Hawkins – Oxford University Press USA, ISBN: 978-0199265152
6. *"Handbook of Physical Measurements" 2nd Edition* – Judith Hall, Judith Allanson, Karen Gripp, Anne Slavotinek – Oxford University Press USA, ISBN: 978-0195301496
7. *"Biomedical Device Technology: Principles And Design"* – Anthony Y. K. Chan – Charles C. Thomas Publisher, ISBN: 978-0398076993

Chairman of the Scientific and Education Council

ET4486 Medical Imaging Systems

1. Course Title: **Medical Imaging Systems**

2. Course ID: ET4486

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Some familiarity with one dimensional Fourier analysis, linear system theory, and probability is suggested

6. Requisites

- Prerequisites: - PH1026, ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

The fundamentals of several engineering disciplines will be combined and applied to analyze the fascinating capabilities found in medical imaging. The course will demonstrate how "black box" analysis can describe the design and performance tradeoffs for diagnostic medical imaging equipment such as projection radiography, computerized tomography (CT), nuclear medicine, ultrasound, and magnetic resonance imaging (MRI)

8. Description

The fundamentals of several engineering disciplines will be combined and applied to analyze the fascinating capabilities found in medical imaging. The course will demonstrate how "black box" analysis can describe the design and performance tradeoffs for diagnostic medical imaging equipment such as projection radiography, computerized tomography (CT), nuclear medicine, ultrasound, and magnetic resonance imaging (MRI)

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 35%
- Mid-term: 25%
- Final exam: 40%

11. Course Materials

- *"Medical Imaging: Signals and Systems"* – Jerry L. Prince, Jonathan Links – Prentice Hall, ISBN: 978-0130653536

12. Course Topics

MEDICAL IMAGING SYSTEMS

Course Developer:

Chapter 1: Introduction

1.1 History
1.2 Basic principles
1.3 Resolution, applications, toxicity

Chapter 2: Imaging Theory

2.1 Review of 1D Linear system theory
2.2 2D superposition and space-invariance
2.3 Sampling theory
2.4 2D Fourier Theory and Theorems
2.5 Hankel Transforms

Chapter 3: Projection Radiography

3.1 X-ray physics
3.2 Attenuation coefficient and scatter
3.3 Source and object magnification
3.4 Recorder considerations
3.5 Poisson processes
3.6 Radiography SNR

Chapter 4: Tomography

4.1 Projection-slice theorem
4.2 Convolution-back projection
4.3 CT hardware
4.4 CT and X-ray Lab Visit

Chapter 5: Magnetic Resonance Imaging

5.1 Spin physics
5.2 Bloch equation
5.3 Signal equation
5.4 K-space trajectories
    5.4.1 Projection reconstruction
    5.4.2 2D Fourier transform trajectory
5.5 Image contrast
5.6 MRI SNR
5.7 Excitation K-space
5.8 MR Imaging Lab

Chapter 6: Ultrasound

6.1 Ultrasound echo equation
    6.1.1 Geometric extension of transducer
6.2 Impulse response

6.2.1 Diffraction (Fresnel and Fraunhofer regions)

6.2.2 Lateral and depth resolution

6.3 Phased array systems

6.4 Ultrasound lab visit

13. Lab works

14. References

1. *"Medical Imaging: Signals and Systems"* – Jerry L. Prince, Jonathan Links – Prentice Hall, ISBN: 978-0130653536
2. *"Imaging Systems for Medical Diagnostics: Fundamentals, Technical Solutions and Applications for Systems Applying Ionizing Radiation, Nuclear Magnetic Resonance and Ultrasound "* – Arnulf Oppelt – Wiley-VCH, ISBN: 978-3895782268
3. *"Medical Imaging Systems Technology" 5-Volume Set* – Cornelius T. Leondes – World Scientific Publishing Company, ISBN: 978-981-256-364-4
4. "*Introduction to Biomedical Imaging*" – Andrew G. Webb – Wiley-IEEE Press, ISBN: 978-0471237662
5. "*Principles of Magnetic Resonance Imaging: A Signal Processing Perspective*" – Zhi-Pei Liang, Paul C. Lauterbur – Wiley-IEEE Press, ISBN: 978-0780347236
6. "*Medical Imaging Physics" 4th Edtion* – William R. Hendee, E. Russell Ritenour – Wiley-Liss, ISBN: 978-0471382263
7. *"The Fourier Transform and its Application" 3rd Edition* – R. N. Bracewell – McGraw-Hill, ISBN: 978-0073039381

Chairman of the Scientific and Education Council

ET4487 The Physics of Diagnostic Radiology

1. Course Title: **The Physics of Diagnostic Radiology**

2. Course ID: ET4487

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Modern physics, calculus, and Fourier analysis

6. Requisites

- Prerequisites: - PH1026, MI1026
- Corequisites: -

7. Objectives and Expected Outcomes

Physics of x-ray diagnostic procedures andequipment, radiation safety, general imaging considerations; lecture and lab

8. Description

Physics of x-ray diagnostic procedures andequipment, radiation safety, general imaging considerations; lecture and lab

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 35%
- Mid-term: 25%
- Final exam: 40%

11. Course Materials

- *"Physics of Radiology" 2nd Ed* – Anthony B. Wolbarst, Gordon Cook – Medical Physics Publishing Corporation, ISBN: 978-1930524224

12. Course Topics

THE PHYSICS OF DIAGNOSTIC RADIOLOGY

Course Developer:

Chapter 1: Basic concepts

1.4 Introduction
1.5 Quantities and Units
1.6 Atoms
1.7 The Nucleus
1.8 Elemental Particles
1.9 Extranuclear Structure
1.10 Atomic Energy Level
1.11 Nuclear Energy Level
1.12 Electromagnetic Radiation
1.13 Quantum Nature of Radiation
1.14 The Electromagnetic Spectrum
1.15 Radiation of Energy from an Atom
1.16 Mass and Energy
1.17 Mass and Velocity
1.18 Exponential Behaviour
1.19 Exponential Decay of a Radioactive Isotope
1.20 Transformation Constant

Chapter 2: The Production and Properties of X-rays

2.6 X-ray tube and simplified circuits
2.7 Self-rectified X-ray circuit
2.8 Rectification
2.9 Three phase units
2.10 Anode and cathode structure
2.11 Ratings of Diagnostic tubes
2.12 X-ray spectra
2.13 Interactions of electrons with the target to give X-ray
2.14 Characteristic Radiation

Chapter 3: Projection Radiography

3.7 X-ray physics
3.8 Attenuation coefficient and scatter
3.9 Source and object magnification
3.10 Recorder considerations
3.11 Poisson processes
3.12 Radiography SNR

Chapter 4: Tomography

4.5 Projection-slice theorem
4.6 Convolution-back projection

4.7 CT hardware
4.8 CT and X-ray Lab Visit

Chapter 5: Magnetic Resonance Imaging
5.9 Spin physics
5.10 Bloch equation
5.11 Signal equation
5.12 K-space trajectories
5.12.1 Projection reconstruction
5.12.2 2D Fourier transform trajectory
5.13 Image contrast
5.14 MRI SNR
5.15 Excitation K-space
5.16 MR Imaging Lab

Chapter 6: Ultrasound
6.5 Ultrasound echo equation
6.5.1 Geometric extension of transducer
6.6 Impulse response
6.6.1 Diffraction (Fresnel and Fraunhofer regions)
6.6.2 Lateral and depth resolution
6.7 Phased array systems
6.8 Ultrasound lab visit

13. Lab works

14. References

1. *"Physics Of Radiology" 2nd Ed* – Anthony B. Wolbarst, Gordon Cook – Medical Physics Publishing Corporation, ISBN: 978-1930524224
2. *"The Essential Physics of Medical Imaging"* 2nd Ed– Jerrold T. Bushberg, J. Anthony Seibert, Edwin M. Leidholdt Jr., John M. Boone – Lippincott Williams & Wilkins, ISBN: 978-0683301182
3. "*Medical Imaging Physics" 4th Edtion* – William R. Hendee, E. Russell Ritenour – Wiley-Liss, ISBN: 978-0471382263
4. "*Radiology Review: Radiologic Physics" 3rd Edition* – Edward L. Nickoloff, Naveed Ahmad – Saunders, ISBN: 978-1416022602

Chairman of the Scientific and Education Council

ET4488 Imaging in Medicine I

1. Course Title: **Imaging in Medicine I**

2. Course ID: ET4488

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: 1 year each of Undergrad physics and calculus

6. Requisites

- Prerequisites: - PH1026, MI1036
- Corequisites: -

7. Objectives and Expected Outcomes

After completion of this course, the student will be able to place the tools for the generation, processing, and interpretation of medical images on a firm conceptual and mathematical foundation. Both the deterministic aspects of linear imaging systems and the stochastic aspects of imaging and imaging systems will be presented.

8. Description

The conceptual, mathematical and statistical aspects of imaging science, and a survey from this formal viewpoint of various medical imaging modalities, including filmscreen radiography, positron and x-ray computed tomography, and magnetic resonance imaging

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 25%
- 1st mid-term: 25%
- 2nd mid-term: 25%
- Final exam: 25%

11. Course Materials

- *"Foundation of Image Sciences" 1st Edtion* – Harrison H. Barrett, Kyle Myers – Wiley-Interscience, ISBN: 978-0471153009

12. Course Topics

IMAGING IN MEDICINE I

Course Developer:

CHAPTER 1. INTRODUCTION TO BIOMEDICAL IMAGING MODALITIES

1.1 Conventional X-Ray Imaging
1.2 Computed Tomography
1.3 Magnetic Resonance Imaging
1.4 Nuclear Imaging
1.5 Ultrasound Imaging
1.6 Electrical Impedance Tomography
1.7 Optical Tomography

CHAPTER 2. MATHEMATICAL FOUNDATIONS

2.1 The Complex Plane
2.2 Odd and Even Functions
2.3 One-Dimensional Delta Function
    2.3.1 Intuitive Definition and Elementary Properties
    2.3.2 Limiting Representations
    2.3.3 Distributional Approach
    2.3.4 Derivatives of Delta Functions
    2.3.5 A Synthesis
2.4 Other Generalized Functions in 1D
    2.4.1 Generalized functions as limits.
    2.4.2 Generalized functions related to the delta function.
    2.4.3 Other point singularities.
2.4 Multidimensional Delta Fucntions
    2.4.1 Multidimensional distributions
    2.4.2 Multidimensional delta functions
    2.4.3 Delta functions in polar coordinates
    2.4.4 Line masses and plane masses
    2.4.5 Multidimensional derivatives of delta functions
    2.4.6 Other point singularities
    2.4.7 Angular delta functions

CHAPTER 3. THEORY OF LINEAR SYSTEMS

3.1 Introduction
3.2 Impulse Response
3.3 The Frequency Domain
3.4 Linear Filters
3.5 Sampling
3.6 Other Measures of Sharpness

CHAPTER 4. FOURIER ANALYSIS

4.1 Sines, Cosines and Complex Exponetials

4.1.1 Orthogonality on a finite interval.
4.1.2 Complex exponentials.
4.1.3 Orthogonality on the infinite interval.
4.1.4 Discrete orthogonality.
4.1.5 The view from the complex plane.
4.2 Fourier Series
4.2.1 Basic concepts.
4.2.2 Convergence of the Fourier series.
4.2.3 Properties of the Fourier coefficients.
4.3 1D Fourier Transform
4.3.1 Basic concepts.
4.3.2 Convergence issues.
4.3.3 Unitarity of the Fourier operator.
4.3.4 Fourier transforms of generalized functions.
4.3.5 Properties of the 1D Fourier transform.
4.3.6 Convolution and correlation.
4.3.7 Fourier transforms of some special functions.
4.3.8 Relation between Fourier series and Fourier transforms.
4.3.9 Analyticity of Fourier transforms.
4.3.10 Related transforms.
4.4 Multidimensional Fourier Transforms
4.4.1 Basis functions.
4.4.2 Definitions and elementary properties.
4.4.3 Multidimensional convolution and correlation.
4.4.4 Rotationally symmetric functions.
4.4.5 Some special functions and their transforms.
4.4.6 Multidimensional periodicity.
4.5 Sampling Theory
4.5.1 Bandlimited functions.
4.5.2 Reconstruction of a bandlimited function from uniform samples.
4.5.3 Aliasing.
4.5.4 Sampling in frequency space.
4.5.5 Multidimensional sampling.
4.5.6 Sampling with a finite aperture.
4.6 Discret Fourier Transform
4.6.1 Motivation and definitions.
4.6.2 Basic properties of the DFT.
4.6.3 Relation between discrete and continuous Fourier transforms.
4.6.4 Discrete-space Fourier Transform.
4.6.5 Fast Fourier Transform.
4.6.6 Multidimensional DFTs.

CHAPTER 5. PROBABILITY FUNDAMENTALS
5.1 Basic Concepts
5.2 Distributions and their moments

5.2.1 Expectation
5.2.2 Mean and Variance
5.3 The Binomial Distribution
5.4 The Poisson Distribution
5.5 The Gaussian Distribution
5.6 Other Distributions
5.7 Characteristic Function
5.8 The Central Limit Theorem

CHAPTER 6. NOISE DETECTOR
6.1 Photon Noise and Short Noise in Photodiodes
6.1.1 Vacuum photodiodes.
6.1.2 Basics of semiconductor detectors.
6.1.3 Shot noise in semiconductor photodiodes.
6.2 X-RAY and Gamma-Ray Detectors
6.2.1 Interaction mechanisms.
6.2.2 Photon-counting semiconductor detectors.
6.2.3 Semiconductor detector arrays.
6.2.4 Position and energy estimation with semiconductor detectors.
6.2.5 Scintillation cameras.
6.2.6 Position and energy estimation with scintillation cameras.
6.2.7 Imaging characteristics of photon-counting detectors.
6.2.8 Integrating detectors.
6.2.9 K x rays and Compton scattering.
6.3 Other Noise Mechanisms
6.3.1 Thermal noise.
6.3.2 Generation-recombination noise.
6.3.3 1/f noise.
6.3.4 Noise in gated integrators.
6.3.5 Arrays of noisy photodetectors.
6.3.6 Spackle noise

CHAPTER 7. INTRODUCTORY TO ELEMENTARY DECISION THEORY
7.1 Basic Concepts
7.1.1 Kinds of decisions.
7.2 Classification Tasks
7.2.1 Partitioning the data space.
7.2.2 Binary decision outcomes.
7.2.3 The ROC curve.
7.2.4 Performance measures for binary tasks.
7.2.5 Computation of AUC.
7.2.6 The likelihood ratio and the ideal observer.
7.2.7 Statistical properties of the likelihood ratio.
7.2.8 Ideal observer with Gaussian statistics.
7.2.9 Ideal observer with non-Gaussian statistics.

7.2.10 Signal variability and the ideal observer.
7.2.11 Background variability and the ideal observer.
7.2.12 The optimal linear discriminant.
7.2.13 Detectability in continuous data.
7.3 Estimation Theory
7.3.1 Basic concepts.
7.3.2 MSE in digital imaging.
7.3.3 Bayesian estimation.
7.3.4 Maximum-likelihood estimation.
7.3.5 Likelihood and Fisher information.
7.3.6 Properties of ML estimators.
7.3.7 Other classical estimators.
7.3.8 Nuisance parameters.
7.3.9 Hybrid detection/estimation tasks.

CHAPTER 8. IMAGE RECONSTRUCTIONS
8.1 Basic Concepts
8.1.1 Classification of Reconstructions
8.1.2 The discretization dilemma.
8.1.3 Estimability.
8.1.4 Positivity.
8.1.5 Choosing the best algorithm
8.2 Linear Reconstruction Operators
8.2.1 Matrix operators for estimation of expansion coefficients.
8.2.2 Reconstruction of functions from discrete data.
8.2.3 Reconstruction from Fourier samples.
8.2.4 Discretization of analytic inverses.
8.2.5 More on analytic inverses.
8.2.6 Noise with linear reconstruction operators.
8.3 Implicit Estimates
8.3.1 Functional minimization.
8.3.2 Data-agreement functionals.
8.3.3 Regularizing functionals.
8.3.4 Effects of positivity.
8.3.5 Reconstruction without discretization.
8.3.6 Resolution and noise in implicit estimates.
8.4 Iterative Algorithms
8.4.1 Linear iterative algorithms.
8.4.2 Noise propagation in linear algorithms.
8.4.3 Search algorithms for functional minimization.
8.4.4 Nonlinear constraints and fixed-point iterations.
8.4.5 Projections onto convex sets.
8.4.6 The MLEM algorithm.
8.4.7 Noise propagation in nonlinear algorithms.
8.4.8 Stochastic algorithms.

13. Lab works

14. References

1. *"Foundation of Image Sciences" 1st Edtion* – Harrison H. Barrett, Kyle Myers – Wiley-Interscience, ISBN: 978-0471153009
2. *"Radiological Imaging: The Theory of Image Formation, Detection, and Processing" 2nd Edition* – Harrison H. Barrett, William Swindell – Academic Press, ISBN: 978-3540300670
3. *"An Introduction to Mathematics of Emerging Biomedical Imaging" 1st Edition* – Habib Ammari – Springer, ISBN: 978-3540795520
4. *"Biomedical Imaging" 1st Edition* – Karen M. Mudry, Robert Plonsey, Joseph D. Bronzino – CRC Press, ISBN: 978-0849318108
5. *"Mathematics and Physics of Emerging Biomedical Imaging" 3rd Edition* – Committee on the Mathematics and Physics of Emerging Dynamic Biomedical Imaging, National Research Council – National Academies Press, ISBN: 978-0309053877
6. *"Introduction to the Mathematics of Medical Imaging" 2nd Edition* – Charles L. Epstein – Society for Industrial & Applied Mathematics, ISBN: 978-0898716429
7. *"Fundamentals of Medical Imaging"* – Paul Suetens – Cambridge University Press, ISBN: 978-0521803625
8. *"Medical Image Processing: The Mathematics of Medical Imaging" 2nd Edition* – James A. Green – Greenwood Research, ISBN: 978-1890121808

Chairman of the Scientific and Education Council

ET4496 Magnetic Resonance Imaging

1. Course Title: **Magnetic Resonance Imaging**

2. Course ID: ET4496

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: modern physics and calculus, Fourier analysis

6. Requisites

- Prerequisites: -
- Corequisites: - ET4486

7. Objectives and Expected Outcomes

Physics and technology of magnetic resonance imaging (MRI), emphasizing techniques employed in medical diagnostic imaging. Major topics: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization

8. Description

Physics and technology of magnetic resonance imaging (MRI), emphasizing techniques employed in medical diagnostic imaging. Major topics: physics of MR, pulse sequences, hardware, imaging techniques, artifacts, and spectroscopic localization

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Mid-term 30%
- Final exam: 40%

11. Course Materials

- *"MRI in Practice" 3rd Edtion* – Catherine Westbrook, Carolyn Kaut Roth, John Talbot – Wiley-Blackwell, ISBN: 978-1405127875

12. Course Topics

MAGNETIC RESONACE IMAGING

Course Developer:

CHAPTER 1. BASICS OF THE MAGNETIC RESONANCE PHENOMENOM

1.1 Spin in a magnetic field
- 1.1.1 Properties of spin
- 1.1.2 Nuclei with spin
- 1.1.3 Energy levels

1.2 The effect of radio frequency pulses

1.3 Relaxation: the return to equilibrium
- 1.3.1 Transverse relaxation
- 1.3.2 Longitudinal relaxation
- 1.3.3 Factors influencing relaxation rates

1.4 The effect of magnetic field gradients

CHAPTER 2. FOURIER TRANSFORMS

2.1 Introduction

2.2 The + and – frequency problem

2.3 The Fourier transform

2.4 Phase correction

2.5 Fourier pairs

2.6 The convolution theorem

2.7 The digital FT

2.8 Sampling error

2.9 The two-dimentional FT

CHAPTER 3. IMAGING PRINCIPLES

3.1 Magnetic field gradient

3.2 Frequency encoding

3.3 Back projection imaging

3.4 Slice selection

CHAPTER 4. Fourier transform imaging principles

4.1 Phase encoding gradient

4.2 FT tomographic imaging

4.3 Signal Processing

4.4 Image resolution

CHAPTER 5. BASIC IMAGING TECHNIQUES

5.1 Multislice imaging

5.2 Oblique imaging

5.3 Spin-echo imaging

5.4 Inversion recovery imaging

5.5 Gradient recalled echo imaging

5.6 Image contrast
5.7 Signal averaging
5.8 Advanced imaging techniques

CHAPTER 6. IMAGING HARDWARE

6.1 Hardware overview
6.2 Magnet
6.3 Gradient coils
6.4 RF coils
6.5 Quadrature detector
6.6 Computer system
6.7 Safety

CHAPTER 7. IMAGE PRESENTATION AND ARTIFACTS

7.1 Image presentation
- 7.1.1 Image histogram
- 7.1.2 Image processing
- 7.1.3 Image coordinates
- 7.1.4 Image planes

7.2 Image artifacts
- 7.2.1 RF quadrature
- 7.2.2 Bo inhomogeneity
- 7.2.3 Gradient
- 7.2.4 RF inhomogeneity
- 7.2.5 Motion
- 7.2.6 Flow
- 7.2.7 Chemical shift
- 7.2.8 Partial volume
- 7.2.9 Wrap around
- 7.2.10 Bibbs ringing

13. Lab works

14. References

1. *"MRI in Practice" 3rd Edtion* – Catherine Westbrook, Carolyn Kaut Roth, John Talbot – Wiley-Blackwell, ISBN: 978-1405127875
2. *"How does MRI work?: An Introduction to the Physics and Function of Magnetic Resonance Imaging " 2nd Edition* – Dominik Weishaupt, Victor D. Koechli, Borut Marincek – Springer, ISBN: 978-3540300670
3. *"Handbook of MRI Technique" 2nd Edition* – Catherine Westbrook – Wiley-Blackwell, ISBN: 978-0632052646
4. "*Principles of Magnetic Resonance Imaging: A Signal Processing Perspective*" – Zhi-Pei Liang, Paul C. Lauterbur – Wiley-IEEE Press, ISBN: 978-0780347236

5. *“Magnetic Resonance Imaging: Theory and Practice” 3rd Edition* – Marinus T. Vlaardingerbroek, Jacques A. den Boer, F. Knoet, A. Luiten – Springer, ISBN: 978-3540436812
6. *“Magnetic Resonance Imaging: Principles, Methods, and Techniques”* - Perry Sprawls – Medical Physics Publishing Corporation, ISBN: 978-0944838976
7. *“Magnetic Resonance Imaging: 3-Volume Set” 3rd Edtion* – David D. Stark, William G., Jr. Bradley – C.V. Mosby, ISBN: 978-0815185185
8. *“Clinical Magnetic Resonance Imaging: 3-Volume Set” 3rd Edition* – Robert R. Edelman, John Hesselink, Michael Zlatkin – Saunders, ISBN: 978-0721603063
9. *“Magnetic Resonance Imaging: Physical and Biological Principles” 3rd Edition* – Stewart C. Bushong – C.V. Mosby, ISBN: 978-0323014854

Chairman of the Scientific and Education Council

ET4497 Diagnostic Ultrasound Physics

1. Course Title: **Diagnostic Ultrasound Physics**

2. Course ID: ET4497

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: modern physics and calculus, Fourier analysis

6. Requisites

- Prerequisites: - PH1026, MI1026
- Corequisites: -

7. Objectives and Expected Outcomes

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound

8. Description

Propagation of ultrasonic waves in biological tissues; principles of ultrasonic measuring and imaging instrumentation; design and use of currently available tools for performance evaluation of diagnostic instrumentation; biological effects of ultrasound

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 20%
- Mid-term 30%
- Final exam: 50%

11. Course Materials

- *"Diagnostic Ultrasound: Physics and Equipment" 3rd Edtion* – Peter Hoskins, Abigail Thrush, Kevin Martin, Tony Whittingam, P. R. Hoskins, A. Thrush, T. Whittingham – Greenwich Medical Media, ISBN: 978-1841100425

12. Course Topics

DIAGNOSTIC ULTRASOUND PHYSICS

Course Developer:

CHAPTER 1. PHYSICS OF DIAGNOSTIC ULTRASOUND

1.5 Nature of sound

1.5.1 Definition of sound (definition, source and motion of sound)

1.5.2 Physical properties (period, frequency, speed, wavelength, amplitude, intensity)

1.5.3 Category of sound wave (according to propagation direction and to frequency)

1.6 Propagation of sound waves

1.6.1 Acoustic impedance

1.6.2 Reflection and transmission at interfaces

1.6.3 Attenuation of ultrasound beams in tissue

CHAPTER 2. PROPERTIES OF ULTRASOUND TRANSDUCERS

2.10 Piezoelectric transducer

2.10.1 Piezoelectric effect

2.10.2 Ceramic elements

2.10.3 Composite piezoelectric materials

2.11 Transducer construction

2.11.1 Basic components

2.11.2 Resonance frequency

2.11.3 Backing material

2.11.4 Matching layers

2.12 Transducer frequency characteristics

2.13 Spatial resolution

2.13.1 Spatial detail in ultrasound

2.13.2 Axial resolution

2.13.3 Lateral resolution

2.14 Transducer beam characteristics

2.14.1 Beam directivity

2.14.2 Huygen wavelets

2.14.3 Near field versus far field

2.14.4 Dependencies on transducer frequency and size

2.14.5 Side lobes

2.14.6 Focused transducers

2.15 Transducer arrays

2.15.1 Type of arrays

2.15.2 Beam formation with an array

2.15.3 Transmit focus

2.15.4 Dynamic receive focus

2.15.5 Slice thickness and elevational resolution

2.15.6 Two-demensional arrays

2.16 Damage to transducers

CHAPTER 3. PULSE-ECHO ULTRASOUND INSTRUMENTATION

3.5 Pulse-echo ultrasound
- 3.5.1 Range equation
- 3.5.2 Pulsing characteristics and duty factor

3.6 Instrumentation
- 3.6.1 Beam former
- 3.6.2 Pulse transmitter
- 3.6.3 Receiver
- 3.6.4 Principal echo display modes (A-mode, B-mode and M-mode)

3.7 Ultrasound B-mode scanning
- 3.7.1 Image build-up
- 3.7.2 Scanning techonology: first generation
- 3.7.3 Real-time scanners

3.8 Frame rate and scanning speed limitations

CHAPTER 4. IMAGE STORAGE AND DISPLAY

4.5 Scan converter memory
- 4.5.1 Role of scan converter
- 4.5.2 Digital devices
- 4.5.3 The scan converter matrix

4.6 Preprocessing and postprocessing
- 4.6.1 Preprocessing
- 4.6.2 Postprocessing

4.7 Display devices
- 4.7.1 Oscilloscope displays
- 4.7.2 Video monitor

4.8 Image recording

CHAPTER 5. DOPPLER INSTRUMENTATION

5.9 Nature of Doppler shift
- 5.9.1 Doppler shift for audible sounds
- 5.9.2 Doppler shift in medical ultrasound

5.10 Continuous-wave Doppler instruments
- 5.10.1 CW Doppler system description
- 5.10.2 CW Doppler transducer

5.11 Directional Doppler

5.12 Pulsed Doppler
- 5.12.1 Pulsed Doppler circuitry
- 5.12.2 The build-up of the Doppler signal
- 5.12.3 Size of the pulsed Doppler sample volume
- 5.12.4 Pulsed Doppler controls
- 5.12.5 Duplex instruments

5.13 Doppler spectral analysis

5.13.1 Characteristics of flow in vessels
5.13.2 Spectral analysis
5.13.3 Information on spectral display
5.14 Aliasing and the Nyquist Frequency
5.14.1 Sampling the Doppler signal
5.14.2 Aliasing
5.14.3 Eliminating aliasing
5.15 Maximum velocity detectable with pulsed Doppler
5.16 High PRF mode

CHAPTER 6. COLOR DOPPLER AND COLOR FLOW IMAGING
6.8 Color flow imaging from Doppler processed echo signal
6.8.1 Acquiring and processing the signal
6.8.2 Properties of color displays
6.8.3 Color aliasing
6.8.4 Doppler power mode
6.9 Color flow imaging using TDC to measure reflector motion
6.9.1 Reflector displacements versus reflector velocity
6.9.2 Time domain correlation

CHAPTER 7. IMAGE CHARACTERISTICS AND ARTIFACTS
7.3 Specular versus diffuse reflection and scattering
7.4 Texture in an ultrasound B-scan image
7.5 Image artifacts
7.5.1 Definition of artifacts
7.5.2 Reverberation artifacts
7.5.3 Comet-tail artifact
7.5.4 Ring-down aftifact
7.5.5 Mirror image artifacts
7.5.6 Doppler spectral mirroring
7.5.7 Beam width effects
7.5.8 Side lobe artifacts
7.5.9 Grating lobe artifacts
7.5.10 Slice thickness artifacts
7.5.11 Shadowing and enhancement (useful artifacts)
7.5.12 Refraction
7.5.13 Speed of sound artifacts
7.6 Distance, area and volume computations
7.6.1 Distance
7.6.2 Area
7.6.3 Volume

13. Lab works

14. References

1. *"Diagnostic Ultrasound: Physics and Equipment" 3rd Edtion* – Peter Hoskins, Abigail Thrush, Kevin Martin, Tony Whittingam, P. R. Hoskins, A. Thrush, T. Whittingham – Greenwich Medical Media, ISBN: 978-1841100425
2. *"Essentials of Ultrasound Physics"*– James A.Zagzebski – C.V. Mosby, ISBN: 978-0815198529
3. *"Ultrasound Physics and Instrumentation" 4th Edition* – Wayne R. Hedrick, David L. Hykes, Dale E. Starchman – C.V. Mosby, ISBN: 978-0323032124
4. *"Ultrasound Physics and Instrumentation" 4th Edition* – Frank R. Miele – Pegasus Lectures Inc , ISBN: 978-1933250083
5. *"Doppler Ultrasound: Physics, Instrumentation and Signal Processing" 2nd Edition* – David H. Evans – Wiley, ASIN: B000V1GVP6
6. *"Diagnostic Ultrasound: Principles and Instruments" 7th Edition* – Frederick W. Kremkau – Saunders, ISBN: 978-0721631929
7. *"Diagnostic Ultrasound: 2-Volume Set" 3rd Edtion* – Carol Rumack, Stephanie Wilson, J. William Charboneau, Jo-Ann Johnson – C.V. Mosby, ISBN: 978-0323020237
8. *"Diagnostic Imaging: Ultrasound" 3rd Edition* – Anil T. Ahuja, James F. Griffith, K. T. Wong, Gregory E. Antonio, Winnie C. W. Chu, Stella S. Y. Ho, Shlok J. Lolge, Bhawan K. Paunipagar, Anne Kennedy, Roya Sohaey, Simon S. M. Ho, Paula Woodward, William J. Zwiebel – AMIRSYS, ISBN: 978-1416049173

Chairman of the Scientific and Education Council

ET4498 Biomedical Optics

1. Course Title: **Biomedical Optics**

2. Course ID: ET4498

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: modern physics and calculus, Fourier analysis

6. Requisites

- Prerequisites: - PH1026, ET4456
- Corequisites: -

7. Objectives and Expected Outcomes

This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the application of optical spectroscopy (absorption, fluorescence and scattering) in biological and biomedical engineering.

8. Description

This course is designed to provide students with a working knowledge of the theoretical and experimental principles underlying the application of optical spectroscopy (absorption, fluorescence and scattering) in biological and biomedical engineering.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Final exam: 70%

11. Course Materials

- *"Biomedical Optics: Principles and Imaging"* – Lihong V. Wang, Hsin-i Wu – Wiley-Interscience, ISBN: 978-0471743040

12. Course Topics

BIOMEDICAL OPTICS

Course Developer:

CHAPTER 1. OPTICAL SPECTROSCOPY

1.1 Definition: interaction of EM rediation with matter

1.2 Type of interactions

- 1.2.1 Absorption
- 1.2.2 Emission
- 1.2.3 Scattering

1.3 Spectroscopic measurements

1.4 Information available from spectrocopy

CHAPTER 2. LIGHT

2.1 Definition of light

- 2.1.1 Classical description (wave)
- 2.1.2 Quantum description (particle)
- 2.1.3 Wave/ particle duality

2.2 Light-matter interaction

- 2.2.1 Atomic spectrum of hydrogen
- 2.2.2 Matter: wave and particle concepts
- 2.2.3 Wave mechanics
- 2.2.4 Atomic orbitals
- 2.2.5 Molecular orbitals

CHAPETR 3. ABSORPTION SPECTROSCOPY

3.1 Energy levels

- 3.1.1 Definition
- 3.1.2 Classification of energies
- 3.1.3 Electronic and vibrational energy levels
- 3.1.4 Population of energy levels

3.2 Absorption spectroscopy

- 3.2.1 Introduction
- 3.2.2 Electronic transitions
- 3.2.3 Biological chromophores
- 3.2.4 Concentration and Beer-Lambert law
- 3.2.5 Absorption spectrophotometer

CHAPTER 4. FLUORESCENCE

4.1 Principles of Fluorescence

- 4.1.1 Luminescence
- 4.1.2 Singlet and triplet states
- 4.1.3 Types of emission
- 4.1.4 Jablonski diagram
- 4.1.5 The fluorescence process
- 4.1.6 Stokes shift and invariance principle

4.2 Quantum Yield and Lifetime
4.2.1 Modified Jablonski diagram
4.2.2 Lifetime
4.2.3 Quantum yield
4.3 Fluorescence Intensity
4.3.1 Fluorescence intensity expression
4.3.2 Fluoerescence spectra
4.4 Fluorescence Spectroscopy
4.5 Biological Fluorophores
4.6 Fluorescence instrumentation
4.6.1 Components of a spectrofluorometer
4.6.2 Description of key components
4.7 Fluorescence measurements
4.8 Fluorescence data
4.9 Fluorescence lifetime
4.9.1 Time resolved fluorescence measurements
4.9.2 Types of measurements
4.9.3 Pulse lifetime theory
4.9.4 Instrument considerations
4.9.5 Single photon counting measurements
4.9.6 Data analysis
4.9.7 Other corrections
4.10 Fluorescence quenching
4.10.1 Dynamic quenching
4.10.2 Static quenching
4.10.3 Comparison
4.10.4 Combined quenching
4.10.5 Experimental considerations

CHAPTER 5. SCATTERING
5.1 Types of scattering
5.1.1 Energy levels
5.1.2 Vibrational transitions
5.1.3 Electronic oscillation
5.2 Elastic scattering
5.2.1 Rayleigh vs. Mie scattering
5.2.2 Biological scatterers
5.3 Properties of elastic scattering

CHAPTER 6. OPTICAL SPECTROSCOPY OF TURBID MEDIA
6.1 Tissue optics
6.1.1 Optical properties
6.1.2 Scattering coefficient
6.1.3 Absorption coefficient
6.1.4 Absorption and scattering

6.2 Models of light transport

6.2.1 Radiative transport equation

6.2.2 Approximation

CHAPTER 7. MONTE CARLO SIMULATIONS

7.1 Introduction

7.2 Selecting the variables

7.3 Rules of photo propagation

7.4 Code

CHAPTER 8. OPTICAL DIAGNOSIS OF BREAST CANCER

8.1 Anatomy and pathology of the breast

8.2 Clinical problems

8.3 Optical spectroscopy

8.3.1 System design and testing

8.3.2 Pre-clinical studies

8.3.3 Analysis and classification

13. Lab works

14. References

1. **"***Biomedical Optics: Principles and Imaging***"** – Lihong V. Wang, Hsin-i Wu – Wiley-Interscience, ISBN: 978-0471743040
2. *"An Introduction to Biomedical Optics"* – Robert Splinter, Brett A. Hooper – Taylor & Francis, ISBN: 978-0750309387
3. *"Optics" 4th Edition* – Eugene Hecht – Addison Wesley, ISBN: 978-0805385663
4. *"Introduction to Optics" 3rd Edition* – Frank L Pedrotti, Leno M Pedrotti, Leno S Pedrotti – Benjamin Cummings, ISBN: 978-0131499331
5. *"Introduction to Biophotonics"* – Paras N. Prasad – Wiley-Interscience, ISBN: 978-0471287704
6. *"Biophotonics: Optical Science and Engineering for the 21st Century"* – Xun Shen, Roeland Van Wijk – Springer, ISBN: 978-0387249957

Chairman of the Scientific and Education Council

ET4506 Imaging in Medicine II

1. Course Title: **Imaging in Medicine II**

2. Course ID: ET4506

3. Course Units: **3(2-1-1-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:

6. Requisites

- Prerequisites: - ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

The conceptual and mathematical foundations of probability and statistics in medical imaging, and demonstrations of the applications of these foundations in particular medical imaging modalities.

8. Description

Continuation of ET4488, with emphasis on stochastic processes as they apply to medical images

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 50%
- Reports: 20%
- Final exam: 30%

11. Course Materials

- **"***Digital Image Processing***"** *3rd Edtion* – Rafael C. Gonzalez, Richard E. Woods – Prentice Hall, ISBN: 978-0131687288

12. Course Topics

IMAGING IN MEDICINE II

Course Developer:

Chapter 1: Introduction

1.1 Elements of Visual Perception
1.2 Light and the Electromagnetic Spectrum
1.3 Image Sensing and Acquisition
1.4 Image Sampling and Quantization
1.5 Some Basic Relationships Between Pixels
1.6 Linear and Nonlinear Operators

Chapter 2: Matlab Fundamentals

2.1 Computer Representation
2.2 Data Classes
2.3 Image Display
2.4 Image File Formats and Image I/O
2.5 Graphical Presentation and Labeling
2.6 Random Number Generator
2.7 Probability Density Functions
2.8 Probability Distribution Functions
2.9 Hypothesis Testing
2.10 Signal Processing Toolbox
2.11 Image Processing Toolbox
2.12 Sampling, Restoration and Interpolation

Chapter 3: Image Reconstruction

3.1 DFT Imaging
    3.1.1 2-Dimensional (or 3D) Fourier Transform Imaging
    3.1.2 Abbe's Theory of Image Formation
3.2 Projection Reconstruction
    3.2.1 Back Projection Method
    3.2.2 Filtered Back Projection Method
    3.2.3 Algebraic Method
    3.2.4 Expectation Maximization Methods
    3.2.5. Radon Transform

Chapter 4: Image Restoration

4.1 A Model of the Image Degradation/Restoration Process
4.1 Noise Models
4.3 Restoration in the Presence of Noise Only-Spatial Filtering
4.3 Periodic Noise Reduction by Frequency Domain Filtering
4.4 Linear, Position-Invariant Degradations
4.5 Estimating the Degradation Function
4.6 Inverse Filtering
4.7 Minimum Mean Square Error (Wiener) Filtering

4.8 Constrained Least Squares Filtering
4.9 Geometric Mean Filter
4.10 Geometric Transformations.

Chapter 5: Satistical Decision Theory
5.1 The Rose Model
5.2 The ROC Analysis
5.3 Windowing and Apodization in Spectral Analysis
5.4 Cross-Correlation and Power Spectral Estimation

Chapter 6: Image Registration
6.1 Introduction
6.2 Type of Transformations
    6.2.1 Dimesionality Transformations
    6.2.2 Degrees of Freedom of the Transformation
6.3 Image Registration Algorithms
    6.3.1 Corresponding Landmark-Based Registration
    6.3.2 Surface-Based Registration
    6.3.3 Registration Based on Voxel Intensities
    6.3.4 2D-3D Registration
6.4 Nonrigid Registration Algorithms
    6.4.1 Intersubject Registration
    6.4.2 Intrasubject Registration
6.5 Optimization
6.6 Transformation of Images
6.7 Validation

Chapter 7: Image Sgmentation
7.1 Detection of Discontinuities
7.2 Edge Linking and Boundary Detection
7.3 Thresholding
7.4 Region-Based Segmentation
7.5 Segmentation by Morphological Watersheds. The Use of Motion in Segmentation.

Chapter 8: Applications
8.1 Imaging Contrast Agents and Compartmental Modeling
8.2 Measurement of Perfusion
8.3 Nuclear Imaging of Cellular Metabolism
8.4 Macromolecular and Biologically Active Contrast Agents
8.5 Targeted Contrast Agents

13. Lab works

14. References

1. **"***Digital Image Processing***"** *3rd Edtion* – Rafael C. Gonzalez, Richard E. Woods – Prentice Hall, ISBN: 9780131687288
2. **"***Digital Image Processing using Matlab***"** – Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins – Prentice Hall, ISBN: 978-0130085191
3. *"Medical Image Analysis"* – Atam Dhawan – Wiley-IEEE Press, ISBN: 978-0471451310
4. *"Handbook of Medical Image Processing and Analysis - Volume 1" 2nd Edition* – Isaac Bankman – Academic Press, ISBN: 978-0123739049
5. *"Handbook of Medical Imaging - Volume 2: Medical Image Processing and Analysis" 1st Edition* – The International Society for Optical Engineering - Jacob Beutel, M. Sonka – National Academies Press, ISBN: 978-0309053877
6. *"Medical Image Registration " 2nd Edition* – Joseph V. Hajnal, Derek L.G. Hill, David J. Hawkes – CRC Press, ISBN: 978-0849300646
7. *"Medical Image Analysis Methods"* – Lena Costaridou – CRC Press, ISBN: 978-0849320897

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ET4516 Introduction to Biomedical Instrumentation

1. Course Title: **Introduction to Biomedical Instrumentation**

2. Course ID: ET4516

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Apply differential equations. Solve electric circuit problems. Write chemical equations

6. Requisites

- Prerequisites: - PH1026, MI1026, ET3026
- Corequisites: -

7. Objectives and Expected Outcomes

- This course will develop the student's ability to select and properly use the optimal instrument for measuring medical variables

- This course will develop the student's ability to select and properly use the optimal instrument for measurement in biological research

- This course will develop the student's ability to search for, select, organize, and present information on a new topic

8. Description

This is a sophomore level first course in bioinstrumentation covering clinical and research measurements. Topics include: designing medical instruments, displacement sensors, temperature and optical sensors, amplifiers and signal processing, cell, nerve, and muscle potentials, electrocardiogram, electrode polarization, surface electrodes, electrocardiograph, power line interference, blood pressure sensors, heart sound sensors, blood flowmeters, impedance plethysmography, respiratory pressure and flow, respiratory gas concentration, blood-gas sensors, noninvasive blood-gas sensors, clinical laboratory measurements, radiography, MRI, ultrasonic imaging, pacemakers and defibrillators, cardiac assist devices, electroshock hazards and protection. Twelve laboratory experiments complement the lectures

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 10%
- Labs: 20%
- Presentation: 10%
- Mid-term: 20%
- Final exam: 40%

11. Course Materials

- *"Bioinstrumentation"* – John G. Webster – Wiley, ISBN: 978-0471263272.

12. Course Topics

INTRODUCTION TO BIOMEDICAL INSTRUMENTATION

Course Developer:

Chapter 1. Measurement Systems

1.1 Studying Bioengineering
1.2 The need for Bioinstrumentation
1.3 Instrumentation
1.4 Errors in Measurements
1.5 Lifelong Learning
1.6 References
1.7 Problems

Chapter 2. Basic Concepts of Electronics

2.1 Electronic Components and Circuit Analysis
2.2 Amplifiers
2.3 Filters
2.4 Analog-to-Digital (ADC) and Digital-to-Analog (DAC) Converters
2.5 Digital Signal Processing
2.6 Microcomputer
2.7 Programming language
2.8 Algorithms
2.9 Medical Information Systems
2.10 Display
2.11 Recorder
2.12 References
2.13 Problems

Chapter 3. Molecules in Clinical Chemistry

3.1 Spectrophotometry
3.2 Oxygen Saturation
3.3 Bilirubin
3.4 Lactate
3.5 Creatinine
3.6 Urea
3.7 Glucose
3.8 Amperometric Biosensors for Oxygen and Glucose
3.9 Ion-Sensitive Electrodes for pH and CO_2
3.10 Flame Photometry
3.11 Spectroscopy
3.12 Mass Spectroscopy
3.13 Carbon Dioxide by Infrared Transmission Spectroscopy
3.14 Nitrogen by Emission Spectroscopy
3.15 Drugs by Fluorometry, Chromatography
3.16 Serum Proteins and Enzymes by Electrophoresis
3.17 References

3.18 Problems

Chapter 4. Molecular Measurements in Biomaterials and Tissue Engineering
4.1 Molecules and Biomaterials
4.2 Molecules and Tissue Engineering
4.3 Surface Analysis
4.4 Protein Adsorption
4.5 Ligand Concentration
4.6 Kinetics of Coupling
4.7 Molecular Solubility
4.8 Surface Mobility
4.9 Mitochondrial Oxygen Consumption
4.10 Biopolymer Structural Integrity
4.11 References
4.12 Problems

Chapter 5. Hematology
5.1 Blood and Its Processing
5.2 Red Blood Cells
5.3 White Blood Cells
5.4 Platelets
5.5 Complete Blood Count
5.6 References
5.7 Problems

Chapter 6. Cellular Measurments in Biomaterials and Tissue Engineering
6.1 Cell Measurement Overview
6.2 Microscopy
6.3 Cellular Markers
6.4 Image Processing
6.5 Cell Orientation
6.6 Cell Rolling Velocity
6.7 Cell Pore Size Determination
6.8 Cell Deformation
6.9 Cell Shear Stress
6.10 Cell Adhesion
6.11 Cell Migration
6.12 Cell Uptake
6.13 Cell Proteins
6.14 Cell Proliferation
6.15 Cell Differentiation
6.16 Cell Signaling and Regulation
6.17 References
6.18 Problems

Chapter 7. Nervous System
7.1 Action Potential
7.2 Brain, EEG and Evoked Potentials
7.3 Brain Imaging: X ray
7.4 Brain Imaging: CT
7.5 Brain Imaging: MRI
7.6 Brain Imaging: Nuclear Imaging
7.7 Brain Imaging: Single-Photon Emission Computed Tomography (SPECT)
7.8 Brain Imaging: Positron Emission Tomography (PET)
7.9 Brain Imaging: Biomagnetism
7.10 Eye, ERG, EOG and Visual Field
7.11 Ear and Audiometry
7.12 Muscles
7.13 References
7.14 Problems

Chapter 8. Heart and Circulation
8.1 Cardiac Anatomy and Physiology
8.2 Cardiac Biopotentials
8.3 Cardiac Pressures
8.4 Cardiac Output
8.5 Cardiac Sounds
8.6 Myocardial Viability
8.7 Circulation
8.8 Blood Flow
8.9 Blood Pressure
8.10 Vessel Distension
8.11 Vessel Volume
8.12 References
8.13 Problems

Chapter 9. Lungs, Kidney, Bone and Skin
9.1 Lung
9.2 Pulmonary Volume
9.3 Pulmonary Flow
9.4 Pulmonary Diffusion
9.5 Pulmonary Resistance
9.6 Kidney
9.7 Kidney Clearance
9.8 Kidney Imaging
9.9 Hemodialysis
9.10 Kidney Function
9.11 Bone
9.12 Skin
9.13 References

9.14 Problems

Chapter 10. Body

10.1 Regulation of Body Temperature
10.2 Clinical Considerations
10.3 Measurement of Surface Temperature
10.4 Core Temperature Measurement
10.5 Measurement of Body Heat: Calorimetry
10.6 Direct Calorimetry
10.7 Indirect Calorimetry
10.8 Measurement of Body Fat
10.9 Direct Measurement of Body Fat
10.10 Indirect Measurement of Body Fat
10.11 Measurement of Body Movement
10.12 Direct Measurement of Body Movement
10.13 Image-Based Measurement of Body Movement
10.14 Safety Measures
10.15 References
10.16 Problems

13. Lab works

14. References

1. *"Bioinstrumentation"* – John G. Webster – Wiley, ISBN: 978-0471263272.
2. *"Bioinstrumentation"* – John D. Enderle – Morgan and Claypool Publishers, ISBN: 978-1598291322.
3. *"Biomedical Instrumentation: Technology and Applications"* – R. S. Khandpur – McGraw-Hill, ISBN: 978-0071447843
4. *"Biomedical Instrumentation Systems"* – Shakti Chatterjee – Delmar Cengage Learning, ISBN: 978-1418018665
5. *"Principles of Bioinstrumentation"* – Richard A. Normann – Wiley Publishers, 1993. ISBN: 978-0471605140
6. *"Principles of Medical Electronics and Biomedical Instrumentation"* – C.R. Rao, S.K. Guha – Universities Press India, ISBN: 978-8173712579
7. *"Bioinstrumentation and Biosensors"* – Donald L. Wise – CRC Publishers, ISBN: 978-0824783372.
8. "Encyclopedia of Medical Devices and Instrumentation" *4-Volume Set* – John G. Webster – Wiley-Interscience, ISBN: 978-0471829362

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ET4526 Medical instrumentation

1. Course Title: **Medical Instrumentation**

2. Course ID: ET4526

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic knowledge of analog amplifier and filter circuits, as appropriate to instrumentation applications

6. Requisites

- Prerequisites: - ET4516, ET3146
- Corequisites: -

7. Objectives and Expected Outcomes

The purpose of the course is to prepare students for choices of either graduate school or employment. They learn the vocabulary of the field by reading the text and from lectures. They learn to analyze systems by solving homework problems. They learn to design systems by performing design themselves by solving homework design problems and by using cooperative learning during lectures. They learn to search for new information using computer databases of articles and patents. They learn to present information by writing a paper.

Students learn best when course expectations are clear. I provide a course outline, homework assignments, exam schedules, grading policies, and list 150 instructional objectives to guide their learning. Exams are open book to encourage learning of problem solving rather than rote learning. Problem-solving skills are essential. Later, when students work on their theses or after graduate work in employment, they must solve problems where the answers are not found in the text or in the teacher's brain.

How can students learn to find information that is not readily available? During homework assignments students search the world wide web, NLS library for books, INSPEC for periodicals, and databases for patents.

How can students learn to select information that is important and reject that which is not? How can the students learn to organize the information in a presentable fashion? Each student writes a paper on a topic not well presented in the text, and I provide feedback to improve their presentation skills.

The above method of instruction prepares students for lifelong learning. Students will know how to find information, select it, and present it.

8. Description

Design and application of electrodes, biopotential amplifiers, biosensors, therapeutic devices. Medical imaging. Electrical safety. Measurement of ventilation, blood pressure and flow

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 10%

- Labs: 20%
- Presentation: 10%
- 1st mid-term: 20%
- 2nd mid-term: 20%
- Final exam: 20%

11. Course Materials

- *"Medical Instrumentation Application and Design" 4th Edition* – John G. Webster – John Wiley & Sons, ISBN: 978-0471676003.

12. Course Topics

MEDICAL INSTRUMENTATION

Course Developer:

Chapter 1. Basic Concepts of Medical Instrumentation

1.1 Terminology of Medicine and Medical Devices
1.2 Generalized Medical Instrumentation System
1.3 Alternative Operational Modes
1.4 Medical Measuarment Constraints
1.5 Classifications of Biomedical Instruments
1.6 Interfering and Modifying Inputs
1.7 Compensation Techniques
1.8 Biostatistics
1.9 Generalized Static Characteristics
1.10 Generalized Dynamic Characteristics
1.11 Design Criteria
1.12 Commercial Medical Instrumentation Development Process
1.13 Regulation of Medical Devices
1.14 Problems
1.15 References

Chapter 2. Basic Sensors and Principles

2.1 Displacement Measuarements
2.2 Resistive Sensors
2.3 Bridge Circuits
2.4 Inductive Sensors
2.5 Capacitive Sensors
2.6 Piezoelectric Sensors
2.7 Temperature Measuarements
2.8 Thermocouples
2.9 Thermistors
2.10 Radiation Thermometry
2.11 Fiber-Optic Temperature Sensors
2.12 Optical Measuarements
2.13 Radiation Sources
2.14 Geometrical and Fiber Optics
2.15 Optical Filters
2.16 Radiation Sensors
2.17 Optical Combinations
2.18 Problems
2.19 References

Chapter 3. Amplifiers and Signal Processing

3.1 Ideal Op Amps
3.2 Inverting Amplifiers

3.3 Noninverting Amplifiers
3.4 Differential Amplifiers
3.5 Comparator
3.6 Rectifiers
3.7 Logarithmic Amplifiers
3.8 Integrators
3.9 Differentiators
3.10 Active Filters
3.11 Frequency Response
3.12 Offset Voltage
3.13 Bias Current
3.14 Input and Output Resistance
3.15 Phase-Sensitive Demodulators
3.16 Microcomputers in Medical Instrumentation
3.17 References
3.18 Problems

Chapter 4. The Origin of Biopotentials
4.1 Electrical Activity of Excitable Cells
4.2 Volume Conductor Fields
4.3 Functional Organization of the Peripheral Nervous System
4.4 The Electroneurogram (ENG)
4.5 The Electromyogram (EMG)
4.6 The Electrocardiogram (ECG)
4.7 The Electroretinogram (ERG)
4.8 The Electroencephalogram (EEG)
4.9 The Magnetoencephalogram (MEG)
4.10 References
4.11 Problems

Chapter 5. Biopotential Electrodes
5.1 The Electrode-Electrolyte Interface
5.2 Polarization
5.3 Polarizable and Nonpolarizable Electrodes
5.4 Electrode Behavior and Circuit Models
5.5 The Electrode-Skin Interface and Motion Artifact
5.6 Body-Surface Recording Electrodes
5.7 Internal Electrodes
5.8 Electrode Arrays
5.9 Microelectrodes
5.10 Electrodes for Electric Stimulation of Tissue
5.11 Practical Hints in Using Electrodes
5.12 References
5.13 Problems

Chapter 6. Biopotential Amplifiers
6.1 Basic Requirements
6.2 The Electrocardiograph
6.3 Problems Frequently Encountered
6.4 Transient Protection
6.5 Common-Mode and Other Interference-Reduction Circuits
6.6 Amplifiers for Other Biopotential Signals
6.7 Example of a Biopotential Preamplifier
6.8 Other Biopotential Signal Processors
6.9 Cardiac Monitors
6.10 Biotelemetry
6.11 References
6.12 Problems

Chapter 7. Blood Pressure and Sound
7.1 Direct Measurements
7.2 Harmonic Analysis of Blood-Pressure Waveforms
7.3 Dynamic Properties of Pressure-Measurement Systems
7.4 Measurement of System Response
7.5 Effects of System Parameters on Response
7.6 Bandwidth Requirements for Measuring Blood Presure
7.7 Typical Pressure-Waveform Distortion
7.8 Systems for Measuring Venous Pressure
7.9 Heart Sounds
7.10 Phonocardiography
7.11 Cardiac Catheterization
7.12 Effects of Potential and Kinetic Energy on Pressure
7.13 Indirect Measurements of Blood Pressure
7.14 Tonometry
7.15 References
7.16 Problems

Chapter 8. Measurement of Flow and Volume of Blood
8.1 Indicator-Dilution Method that Uses Continuous Infusion
8.2 Indicator-Dilution Method that Uses Rapid Injection
8.3 Electromagnetic Flowmeters
8.4 Ultrasonic Flowmeters
8.5 Thermal-Convection Velocity Sensors
8.6 Chamber Plethysmography
8.7 Electric-Impedance Plethysmography
8.8 Photoplethysmography
8.9 References
8.10 Problems

Chapter 9. Measurements of The Respiratory System
9.1 Modeling the Respiratory System
9.2 Measurement of Pressure
9.3 Measurement of Gas-Flow Rate
9.4 Lung Volume
9.5 Respiratory Plethysmography
9.6 Some Tests of Respiratory Mechanicss
9.7 Measurement of Gas Concentration
9.8 Some Tests of Gas Transport
9.9 References
9.10 Problems

Chapter 10. Chemical Biosensors
10.1 Blood-Gas and Acid-Base Physiology
10.2 Electrochemical Sensors
10.3 Chemical Fibrosensors
10.4 Ion-Selective Field-Effect Transistor (ISFET)
10.5 Immunologically Sensitive Field-Effect Transistor (IMFET)
10.6 Noninvasive Blood-Gas Monitoring
10.7 Blood-Glucose Sensors
10.8 Summary
10.9 References
10.10 Problems

Chapter 11. Clinical Laboratory Instrumentation
11.1 Spectrophotometry
11.2 Automated Chemical Analyzers
11.3 Chromatology
11.4 Electrophoresis
11.5 Hematology
11.6 References
11.7 Problems

Chapter 12. Medical Imaging Systems
12.1 Information Content of an Image
12.2 Modulation Transfer Function
12.3 Noise-Equivalent Bandwidth
12.4 Photography
12.5 Television Systems
12.6 Radiography
12.7 Computed Radiography
12.8 Computed Tomography
12.9 Magnetic Resonance Imaging
12.10 Nuclear Medicine
12.11 Single-Photon Emission Computed Tomography

12.12 Position Emission Tomography
12.13 Ultrasonography
12.14 References
12.15 Problems

Chapter 13. Therapeutic and Prosthetic Devices
13.1 Cardiac Pacemakers and Other Electric Stimulators
13.2 Defibrillators and Cardioverters
13.3 Mechanical Cardiovascular Orthotic and Prosthetic Devices
13.4 Hemodialysis
13.5 Lithotripsy
13.6 Ventilators
13.7 Infant Incubators
13.8 Drug Delivery Devices
13.9 Surgical Instruments
13.10 Therapeutic Applications of the Laser
13.11 References
13.12 Problems

Chapter 14. Electrical Safety
14.1 Physiological Effects of Eletricity
14.2 Important Susceptibility Parameters
14.3 Distribution of Electric Power
14.4 Macroshock Hazards
14.5 Microshock Hazards
14.6 Electrical-Safety Codes and Standards
14.7 Basic Approaches to Protection Against Shock
14.8 Protection: Power Distribution
14.9 Protection: Equipment Design
14.10 Electrical-Safety Analyzers
14.11 Testing the Electric System
14.12 Tests of Electric Appliances
10.9 References
10.10 Problems

13. Lab works

14. References

1. *"Medical Instrumentation Application and Design" 4th Edition* – John G. Webster – John Wiley & Sons, ISBN: 978-0471676003.
2. *"Design and Development of Medical Electronic Instrumentation: A Practical Perspective of the Design, Construction, and Test of Medical Devices"* – David Prutchi, Michael Norris – Wiley-Interscience Publisher, ISBN: 978-0471676232.
3. *"Noninvasive Instrumentation and Measurement in Medical Diagnosis"* - Robert B. Northrop – CRC, ISBN: 978-0849309618

4. *“Design of Pulse Oximeters”* – John G. Webster – Taylor & Francis Publisher, ISBN: 978-0750304672.
5. *“Pulse Oximetry: Principles and Practice” 2nd Edition* – John Moyle – BMJ Books Publisher, ISBN: 978-0727917409.
6. *“Biomedical Instrumentation: Technology and Applications”* – R. S. Khandpur – McGraw-Hill, ISBN: 978-0071447843.

Chairman of the Scientific and Education Council

ET4536 Physics of Radiotherapy

1. Course Title: **Physics of Radiotherapy**

2. Course ID: ET4536

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:

6. Requisites

- Prerequisites: - PH1026
- Corequisites: -

7. Objectives and Expected Outcomes

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications; lecture and lab

8. Description

Ionizing radiation use in radiation therapy to cause controlled biological effects in cancer patients. Physics of the interaction of the various radiation modalities with body-equivalent materials, and physical aspects of clinical applications; lecture and lab

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Final exam: 70%

11. Course Materials

- *"Radiotherapy Physics: in Practice" 2nd Edition* – J. R. Williams, D. I. Thwaites – Oxford University Press, ISBN: 978-0192628787

12. Course Topics

PHYSICS OF RADIOTHERAPY

Course Developer:

Chapter 1: Introduction

1.1 The development of radiotherapy
1.2 Radiotherapeutic aims
1.3 Radiotherapy methods
    1.3.1 External beam therapy
    1.3.2 Brachytherapy
    1.3.3 Unsealed-source therapy
1.4 Requirements for accuracy and precision
1.5 Quality assurance

Chapter 2: Planning and acceptance testing of megavoltage therapy installations

2.1 Introduction
2.2 Types of equipment
    2.2.1 Cobalt-60 machines
    2.2.2 Linear accelerators
    2.2.3 Special machines and ancillary equipment
2.3 Equipment specification
    2.3.1 Mechanical
    2.3.2 Radiation performance
2.4 Machine-selection criteria
2.5 Treament room and design
    2.5.1 Location
    2.5.2 Size and shape
    2.5.3 Shielding calculations
    2.5.4 Console area
    2.5.5 Other considerations

Chapter 3: Absolute dose determination for high-energy photon and electron beams

3.1 Introduction
3.2 Specification of beam quality
    3.2.1 X-ray beams
    3.2.2 Electron beams
3.3 Calibration of ionization chambers
3.4 Derivation of absorbed dose to water using calibrated ionization chambers
3.5 Pratical application of protocols
    3.5.1 Measurement correction factors
    3.5.2 Air calibration correction factors
    3.5.3 In-phantom correction factors
    3.5.4 Non-water phantoms
3.6 Calibration of the dose monitor
    3.6.1 Photon beams
    3.6.2 Electron beams

3.7 Accuracy of the absolute dose determination

Chapter 4: Simulation and imaging for radiation therapy planning

4.1 Introduction

4.2 Definitions related to patient planning

- 4.2.1 Gross tumour volume (GTV)
- 4.2.2 Clinical target volume (CTV)
- 4.2.3 Planning target volume (PTV)
- 4.2.4 Treated volume
- 4.2.5 Irradiated volume
- 4.2.6 Organs at risk
- 4.2.7 Absorbed dose distribution

4.3 Methods of deriving patient-specific data

- 4.3.1 Patient positioning
- 4.3.2 measurement of external contours and internal anatomy

4.4 Simulators

- 4.4.1 Role of treatment simulation
- 4.4.2 Specifications
- 4.4.3 Selection criteria, purchase and acceptance

4.5 CT scanners for therapy planning

- 4.5.1 Role of CT scanners
- 4.5.2 Pratical considerations
- 4.5.3 Specifications
- 4.5.4 Selection criteria, purchase and acceptance

4.6 CT simulators

- 4.5.1 Role of CT simulators
- 4.5.2 Pratical considerations
- 4.5.3 Specifications
- 4.5.4 Acceptance and implementation of virtual simulation

Chapter 5: Treatment planning for external bem therapy: principles and basic techniques

5.1 Introduction

5.2 General principles and planning techniques

- 5.2.1 Single fields
- 5.2.2 Opposed coxial fields
- 5.2.3 Factors affecting dose distributions
- 5.2.4 Multiple fields

5.3 Dose calculation within the patient

- 5.3.1 Correction methods for patient shape
- 5.3.2 Correction methods for patient composition

5.4 Optimization

- 5.4.1 Specification of the planning problem
- 5.4.2 Visual optimization

5.4.3 Score functions
5.4.4 Mathematical optimization
5.5 Computer planning
5.5.1 Hardware requirements
5.5.2 Beam data input and storage
5.5.3 Patient data input and storage
5.5.4 Calculation of dose distributions
5.6 Standard – treatment planning
5.6.1 Pelvis
5.6.2 Oesophagus
5.6.3 Bronchus
5.6.4 Breast
5.6.5 Larynx
5.6.6 Floor of mouth
5.6.7 Maxillary antrum
5.7 Treatment with non-standard fields
5.7.1 Irregular field calculations
5.7.2 Compensators
5.7.3 Asymmetric collimators
5.7.4 Monitor unit calculations

Chapter 6: Treatment planning for external beam therapy: advanced techniques
6.1 CT planning
6.1.1 Scanning techniques
6.1.2 Outlining and target drawing
6.1.3 Tools available for 3-D planning
6.1.4 Dose display and reporting
6.1.5 Dose-calculation algorithms
6.2 Conformal therapy
6.2.1 Definition and rationale
6.2.2 Selection of beam directions
6.2.3 Asymmetric collimators
6.2.4 Customized blocking
6.2.5 Multi-leaf collimators (MLC)
6.2.6 Treatment set-up and verification
6.3 Dynamic therapy
6.3.1 Arc therapy
6.3.2 Dynamic wedge
6.3.3 Beam-intensity modulation
6.3.4 Automated treatment
6.4 Stereotactic radiotherapy

Chapter 7: Electron beam treatment - planning techniques
7.1 Introduction
7.2 Beam characteristics

7.2.1 Depth dose
7.2.2 Isodose
7.2.3 Field-size variations
7.3 Choice of energy and beam size
7.4 Field shaping
7.5 Output factors
7.6 Non-standard treatment distances
7.7 Oblique incidence
7.8 Inhomogeneities
7.8.1 Absorption (bulk) effects
7.8.2 Scatter (egde) effects
7.8.3 Bolus
7.9 Internal shielding
7.10 Adjacent fields
7.11 Electron arc therapy
7.12 Total skin electron irradiation
7.13 Other techniques
7.14 Electron-beam algorithms

Chapter 8: Brachytherapy
8.1 Introduction
8.2 Sealed radioactive sources
8.3 Sealed-source dosimetry
8.4 Radiation protection and quality assurance
8.5 Afterloading systems
8.6 Dosimetry systems
8.7 Practical aspects of absorbed dose calculation
8.8 Radiobiological models

13. Lab works

14. References

1. *"Radiotherapy Physics: in Practice" 2nd Edition* – J. R. Williams, D. I. Thwaites – Oxford University Press, ISBN: 978-0192628787
2. *"Walter & Miller's Textbook of Radiotherapy: Radiation Physics, Therapy and Oncology" 6th Edition* – C. K. Bomford, I. H. Kunkler – Churchill Livingstone, ISBN: 978-0443062018
3. "*The Physics of Radiotherapy X-Rays And Electrons*" – Peter Metcalfe, Tomas Kron, Peter Hoban – Medical Physics Publishing Corporation, ISBN: 978-1930524361
4. "*The Physics of Three Dimensional Radiation Therapy: Conformal Radiotherapy, Radiosurgery and Treatment Planning"* – Steve Webb – Taylor & Francis, ISBN: 978-0750302548

5. *“Handbook of Radiotherapy Physics: Theory and Practice”* - P Mayles, A Nahum, J.C Rosenwald – Taylor & Francis, ISBN: 978-0750308601
6. *“Clinical Radiotherapy Physics: Basic Physics and Radiation Dosimetry”* - Subramania Jayaraman, Lawrence H. Lanzl – CRC Press, ISBN: 978-0849368912

Chairman of the Scientific and Education Council

ET4546 Health Information Systems

1. Course Title: **Health Information Systems**

2. Course ID: ET4546

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:.

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

- Critically appraise the application of information technologies to the challenges of health care.

- Evaluate organizational, industrial, and regulatory issues that influence the design and success of information systems for health care

- Design engineering solutions to improve the acquisition, storage, display and manipulation of health information.

- Demonstrate skill in written and spoken discourse (analysis, critique, presentation)

8. Description

Provides grounding in core concepts of health information systems. Major applications include clinical information systems, language andstandards, decision support, image technology and digital libraries. Evaluation of IE tools and perspectives designed to improve the quality, efficiency and effectiveness of health information

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Mid-term: 30%
- Final exam: 40%

11. Course Materials

- *"Biomedical Informatics: Computer Applications in Health Care and Biomedicine" 3rd Edition* – Edward H. Shortliffe, James J. Cimino – Springer-Verlag, ISBN: 978-0387289861.

12. Course Topics

HEALTH INFORMATION SYSTEMS

Course Developer:

Chapter 1. Welcome and Overview of Field

1.1 A discipline whose time has come
1.2 The discipline of biomedical informatics
1.3 Problems in health care motivating biomedical informatics
1.4 Seminal documents and reports
1.5 Resources of field - organizations, information, education

Chapter 2. Biomedical Computing

2.1 Types of Computers
2.2 Data Storage in Computers
2.3 Computer Hardware and Software
2.4 Computer Networks
2.5 Software Engineering
2.6 Challenges for Biomedical Computing

Chapter 3. Electronic Health Records

3.1 Clinical Data
3.2 History and Perspective of the Health (Medical) Record
3.3 Potential Benefits of the Electronic Health Record
3.4 Definitions and Key Attributes of the EHR
3.5 EHR Examples
3.6 Nursing Informatics

Chapter 4. Clinical Decision Support; HER Implementation

4.1 Historical Perspectives and Approaches
4.2 Medical Errors and Patient Safety
4.3 Reminders and Alerts
4.4 Computerized Provider Order Entry (CPOE)
4.5 Implementing the EHR
4.6 Use and Outcomes of the EHR
4.7 Cost-Benefit of the HER

Chapter 5. Standards and Interoperability; Privacy, Confidentiality, and Security

5.1 Standards: Basic Concepts
5.2 Identifier and Transaction Standards
5.3 Message Exchange Standards
5.4 Terminology Standards
5.5 Privacy, Confidentiality, and Security: Basic Concepts
5.6 HIPAA Privacy and Security Regulations

Chapter 6. Secondary Use of Clinical Data: Personal Health Records, Health Information Exchange, Public Health, Health Care Quality, Clinical Research

6.1 Personal Health Records
6.2 Health Information Exchange
6.3 Public Health Informatics
6.4 Health Care Quality
6.5 Clinical Research Informatics

Chapter 7. Evidence-Based Medicine (EBM) and Medical Decision Making

7.1 Definitions and Application of EBM
7.2 Interventions
7.3 Diagnosis
7.4 Harm and Prognosis
7.5 Summarizing Evidence
7.6 Putting Evidence into Practice
7.7 Limitations of EBM

Chapter 8. Information Retrieval and Digital Libraries

8.1 Information Retrieval
8.2 Knowledge-based Information
8.3 Content
8.4 Indexing
8.5 Retrieval
8.6 Evaluation
8.7 Digital Libraries

Chapter 9. Imaging Information and Telemedicine

9.1 Imaging in Health Care
9.2 Modalities of Imaging
9.3 Digital Imaging
9.4 Telemedicine: Definitions and Barriers
9.5 Efficacy of Telemedicine

Chapter 10. Translational Bioinformatics

10.1 Translational Bioinformatics - The Big Picture
10.2 Overview of Basic Molecular Biology
10.3 Important Biotechnologies Driving Bioinformatics
10.4 Genetics-Related Diseases
10.5 Bioinformatics Information Resources
10.6 Translational Bioinformatics Challenges and Opportunities

13. Lab works

7 x 3-hour lab

14. References

1. *"Biomedical Informatics: Computer Applications in Health Care and Biomedicine" 3rd Edition* – Edward H. Shortliffe, James J. Cimino – Springer-Verlag, ISBN: 978-0387289861.
2. *"Biomedical Information Technology"* – David Dagan Feng – Elsevier Inc, ISBN: 978-0123735836
3. *"Biomedical Informatics"* – Jules J. Berman – Jones & Bartlett Publishers, ISBN: 978-0763741358
4. *"Handbook of Medical Informatics" 2nd Edition* – J. van Bemmel, M.A. Musen, Mark A. Musen – Springer, ISBN: 978-3540633518
5. *"Healthcare Informatics and Information Synthesis: Developing and Applying Clinical Knowledge to Improve Outcomes"* – John W. Williamson, Charlene R. Weir, Charles W. Turner, Michael J. Lincoln – Sage Publications, ISBN: 978-0761908241
6. *"Medical Informatics: Knowledge Management and Data Mining in Biomedicine"* – Hsinchun Chen, Sherrilynne S. Fuller, Carol Friedman, William Hersh – Springer, ISBN: 978-0387243818
7. *"Medical Informatics: Practical Guide for the Healthcare Professional 2007"* – Robert Hoyt, Melanie Sutton, Ann Yoshihashi – Lulu.com, ISBN: 978-1430321620

Chairman of the Scientific and Education Council

ET4556 Patient Safety and Error Reduction in Healthcare

1. Course Title: **Patient Safety and Error Reduction in Healthcare**

2. Course ID: ET4556

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:.

6. Requisites

- Prerequisites: -
- Corequisites: -

7. Objectives and Expected Outcomes

Techniques for evaluating and reducing risks in medical procedures, including probabilistic risk assessment methods, failure mode and effects analysis, human factors analysis, and quality management. Discussions of patient safety standards, recommendations from agencies, and continual quality improvement.

8. Description

Techniques for evaluating and reducing risks in medical procedures, including probabilistic risk assessment methods, failure mode and effects analysis, human factors analysis, and quality management. Discussions of patient safety standards, recommendations from agencies, and continual quality improvement.

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Final exam: 70%

11. Course Materials

- *"Error Reduction in Health Care: A Systems Approach to Improving Patient Safety"* – Patrice L. Spath – Jossey-Bass, ISBN: 978-0787955960

12. Course Topics

PATIENT SAFETY AND ERROR REDUCTION IN HEALTHCARE

Course Developer:

Chapter 1: Risk Factors, Safety, and Management of Medical Equipment

1.1 Risk Management: A Definition
1.2 Risk Management: Historical Perspective
1.3 Risk Management: Strategies
1.4 Risk Management: Application
1.5 Case Studies
1.6 Conclusions

Chapter 2: Introduction of ionnization radiation

2.1 Radioactivity and radiation
- 2.1.1 Introduction
- 2.1.2 Alpha, beta and gamma radiation
- 2.1.3 The electronvolt
- 2.1.4 The mechanism of radioactive decay
- 2.1.5 Natural radioactive series
- 2.1.6 Induced radioactivity
- 2.1.7 The unit of radioactivity
- 2.1.8 The nuclide chart
- 2.1.9 Interaction of radiation with matter
- 2.1.10 Penetrating powers of nuclear radiations

2.2 Biological effects of radiation
- 2.2.1 Introduction
- 2.2.2 Basic human physiology
- 2.2.3 Cell biology
- 2.2.4 The interation of radiation with cells
- 2.2.5 Deterministic effects
- 2.2.6 Stochastic effects – cancer induction
- 2.2.7 Stochastic effects – hereditary

Chapter 3: Radiation protection in medicine

3.1 The system of radiological protection
- 3.1.1 The role of the ICRP
- 3.1.2 The 1991 recommendations of the ICRP (publication 60)
- 3.1.3 Recommended dose limits for workers
- 3.1.4 Notes on the dose limits for workers
- 3.1.5 Recommended dose limits for invidual members of the public
- 3.1.6 Abnormal exposures in emergencies or accidents

3.2 Radiation detection and measurement
- 3.2.1 General principles
- 3.2.2 Ionization of a gas
- 3.2.3 Solid state detectors
- 3.2.4 Photographic effect

3.2.5 Activation effect
3.2.6 Electrical circuits
3.3 The external radiation hazard
3.3.1 Source of the hazard
3.3.2 Time
3.3.3 Distance
3.3.4 Shielding
3.3.5 Neutron sources
3.3.6 Personal dose control
3.3.7 Radiation survey monitoring
3.3.8 Personel monitoring equipment
3.3.9 Radiation records
3.4 The internal radiation hazard
3.4.1 Uncontained radioactivity
3.4.2 Routes of entry
3.4.3 Annual limits of intake
3.4.4 Control of the contamination hazard
3.4.5 Routine control of contamination
3.4.6 Radiotoxicity and laboratory classification
3.4.7 Design of areas for radioactive work
3.4.8 Treatment of contaminated personel
3.4.9 Contamination monitoring
3.5 X-rays and radiography
3.5.1 Introduction
3.5.2 X ray equipment
3.5.3 Quality and intensity of X-rays
3.5.4 Protection against X-rays
3.5.5 Monitoring of X-ray installations
3.6 Radiation protection in medicine
3.6.1 Applications
3.6.2 General principles and organization
3.6.3 Protection against sealed sources
3.6.4 Protection against unsealed sources
3.6.5 Control and disposal of radioactive materials

Chapter 4: Electrical Safety
4.1 Physiological effects of electricity
4.2 Important susceptibility parameters
4.3 Distribution of electric power
4.4 Macroshock hazards
4.5 Microshock hazards
4.6 Electrical-safety codes and standards
4.7 Basic approaches to protection against shock
4.8 Protection: Power distribution
4.9 Protection: Equipment design

4.10 Electrical-safety analyzers
4.11 Testing the electric system
4.12 Tests of electric appliances

13. Lab works

14. References

1. *"Error Reduction in Health Care: A Systems Approach to Improving Patient Safety"* – Patrice L. Spath – Jossey-Bass, ISBN: 978-0787955960
2. *"Understanding Patient Safety"* – Robert M. Wachter – McGraw-Hill, ISBN: 978-0071482776
3. *"Patient Safety: Achieving a New Standard for Care"* – Philip Aspden, Janet M. Corrigan, Julie Wolcott, Shari M. Erickson - National Academies Press, ISBN: 978-0309090773
4. *"The Healthcare Quality Book: Vision, Strategy, and Tools"* – Scott B. Ransom, Maulik S. Joshi, David B. Nash – Health Administration Press, ISBN: 978-1567932249
5. *"Measuring Quality Improvement in Healthcare: A Guide to Statistical Process Control Applications"* – Raymond G. Carey, Robert C. Lloyd – American Society for Quality, ISBN: 978-0527762933
6. *"Health Care Management: Organization Design and Behavior" 5th Edition* – Stephen M. Shortell, Arnold D. Kaluzny – Delmar Cengage Learning, ISBN: 978-1418001896
7. *"Quality Management in Health Care: Principles and Methods" 2nd Edition* – Donald E.Lighter, Douglas C. Fair – Jones and Bartlett Publishers, ISBN: 978-0763732189

Chairman of the Scientific and Education Council

ET4566 Image Processing

1. Course Title: **Image Processing**

2. Course ID: ET4566

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Linear signals and systems. Basic linear algebra. Basic probability. Basic programming techniques.

6. Requisites

- Prerequisites: - MI1046, ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

- This course is designed to give first-year graduate students and seniors in ECE a fundamental understanding of digital image processing techniques, including image enhancement, restoration, coding, and low level image analysis.

8. Description

Mathematical representation of continuous and digital images; models of image degradation; picture enhancement, restoration, segmentation, and coding; pattern recognition, tomography

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 15%
- Labs: 15%
- Projects: 20%
- Mid-term: 20%
- Final exam: 30%

11. Course Materials

- "*Digital Image Processing*" *3rd Edition* – Rafael C. Gonzalez, Richard E. Woods – Prentice Hall, ISBN: 9780131687288

12. Course Topics

DIGITAL IMAGE PROCESSING

Course Developer:

CHAPTER 1: INTRODUCTION

1.1 What Is Digital Image Processing?
1.2 The Origins of Digital Image Processing
1.3 Examples of Fields that Use Digital Image Processing
    1.3.1 Gamma-Ray Imaging
    1.3.2 X-Ray Imaging
    1.3.3 Imaging in the Ultraviolet Band
    1.3.4 Imaging in the Visible and Infrared Bands
    1.3.5 Imaging in the Microwave Band
    1.3.6 Imaging in the Radio Band
    1.3.7 Examples in which Other Imaging Modalities Are Used
1.4 Fundamental Steps in Digital Image Processing
1.5 Components of an Image Processing System

CHAPTER 2 DIGITAL IMAGE FUNDAMENTALS

2.1 Elements of Visual Perception
    2.1.1 Structure of the Human Eye
    2.1.2 Image Formation in the Eye
    2.1.3 Brightness Adaptation and Discrimination
2.2 Light and the Electromagnetic Spectrum
2.3 Image Sensing and Acquisition
    2.3.1 Image Acquisition Using a Single Sensor
    2.3.2 Image Acquisition Using Sensor Strips
    2.3.3 Image Acquisition Using Sensor Arrays
    2.3.4 A Simple Image Formation Model
2.4 Image Sampling and Quantization
    2.4.1 Basic Concepts in Sampling and Quantization
    2.4.2 Representing Digital Images
    2.4.3 Spatial and Intensity Resolution
    2.4.4 Image Interpolation

CHAPTER 3: INTENSITY TRANSFORMATIONS AND SPATIAL FILTERING

3.1 Background
    3.1.1 The Basics of Intensity Transformations and Spatial Filtering
    3.1.2 About the Examples in This Chapter
3.2 Some Basic Intensity Transformation Functions
    3.2.1 Image Negatives
    3.2.2 Log Transformations
    3.2.3 Power-Law (Gamma) Transformations
    3.2.4 Piecewise-Linear Transformation Functions
3.3 Histogram Processing

3.3.1 Histogram Equalization
3.3.2 Histogram Matching (Specification)
3.3.3 Local Histogram Processing
3.3.4 Using Histogram Statistics for Image Enhancement
3.4 Fundamentals of Spatial Filtering
3.4.1 The Mechanics of Spatial Filtering
3.4.2 Spatial Correlation and Convolution
3.4.3 Vector Representation of Linear Filtering
3.4.4 Generating Spatial Filter Masks
3.5 Smoothing Spatial Filters
3.5.1 Smoothing Linear Filters
3.5.2 Order-Statistic (Nonlinear) Filters
3.6 Sharpening Spatial Filters
3.6.1 Foundation
3.6.2 Using the Second Derivative for Image Sharpening—The Laplacian
3.6.3 Unsharp Masking and Highboost Filtering
3.6.4 Using First-Order Derivatives for (Nonlinear) Image Sharpening—The Gradient
3.7 Combining Spatial Enhancement Methods

CHAPTER 4: FILTERING IN THE FREQUENCY DOMAIN
4.1 Background
4.1.1 A Brief History of the Fourier Series and Transform
4.1.2 About the Examples in this Chapter
4.2 Preliminary Concepts
4.2.1 Complex Numbers
4.2.2 Fourier Series
4.2.3 Impulses and Their Sifting Property
4.2.4 The Fourier Transform of Functions of One Continuous Variable
4.2.5 Convolution
4.3 Sampling and the Fourier Transform of Sampled Functions
4.3.1 Sampling
4.3.2 The Fourier Transform of Sampled Functions
4.3.3 The Sampling Theorem
4.3.4 Aliasing
4.3.5 Function Reconstruction (Recovery) from Sampled Data
4.4 The Discrete Fourier Transform (DFT) of One Variable
4.4.1 Obtaining the DFT from the Continuous Transform of a Sampled Function
4.4.2 Relationship Between the Sampling and Frequency Intervals
4.6 Some Properties of the 2-D Discrete Fourier Transform
4.6.1 Relationships Between Spatial and Frequency Intervals
4.6.2 Translation and Rotation
4.6.3 Periodicity
4.6.4 Symmetry Properties
4.6.5 Fourier Spectrum and Phase Angle

4.6.6 The 2-D Convolution Theorem

CHAPTER 5: IMAGE RESTORATION AND RECONSTRUCTION
5.1 A Model of the Image Degradation/Restoration Process
5.2 Noise Models
5.2.1 Spatial and Frequency Properties of Noise
5.2.2 Some Important Noise Probability Density Functions
5.2.3 Periodic Noise
5.2.4 Estimation of Noise Parameters
5.3 Restoration in the Presence of Noise Only—Spatial Filtering
5.3.1 Mean Filters
5.3.2 Order-Statistic Filters
5.3.3 Adaptive Filters
5.5 Linear, Position-Invariant Degradations
5.6 Estimating the Degradation Function
5.6.1 Estimation by Image Observation
5.6.2 Estimation by Experimentation
5.6.3 Estimation by Modeling
5.7 Inverse Filtering
5.8 Minimum Mean Square Error (Wiener) Filtering
5.9 Constrained Least Squares Filtering
5.10 Geometric Mean Filter

CHAPTER 6: MORPHOLOGICAL IMAGE PROCESSING
6.1 Preliminaries
6.2 Erosion and Dilation
6.2.1 Erosion
6.2.2 Dilation
6.2.3 Duality
6.3 Opening and Closing
6.4 The Hit-or-Miss Transformation
6.5 Some Basic Morphological Algorithms
6.5.1 Boundary Extraction
6.5.2 Hole Filling
6.5.3 Extraction of Connected Components
6.5.4 Convex Hull
6.5.5 Thinning
6.5.6 Thickening
6.5.7 Skeletons
6.5.8 Pruning
6.5.9 Morphological Reconstruction

CHAPTER 7: IMAGE SEGMENTATION
7.1 Fundamentals
7.2 Point, Line, and Edge Detection

7.2.1 Background
7.2.2 Detection of Isolated Points
7.2.3 Line Detection
7.2.4 Edge Models
7.2.5 Basic Edge Detection
7.2.6 More Advanced Techniques for Edge Detection
7.2.7 Edge Linking and Boundary Detection
7.3 Thresholding
7.3.1 Foundation
7.3.2 Basic Global Thresholding
7.3.3 Optimum Global Thresholding Using Otsu's Method
7.3.4 Using Image Smoothing to Improve Global Thresholding
7.3.5 Using Edges to Improve Global Thresholding
7.3.6 Multiple Thresholds
7.3.7 Variable Thresholding
7.3.8 Multivariable Thresholding
7.4 Region-Based Segmentation
7.4.1 Region Growing
7.4.2 Region Splitting and Merging
7.5 Segmentation Using Morphological Watersheds
7.5.1 Background
7.5.2 Dam Construction
7.5.3 Watershed Segmentation Algorithm
7.5.4 The Use of Markers

CHAPTER 8: REPRESENTATION AND DESCRIPTION
8.1 Representation
8.1.1 Boundary (Border) Following
8.1.2 Chain Codes
8.1.3 Polygonal Approximations Using Minimum-Perimeter Polygons
8.1.4 Other Polygonal Approximation Approaches
8.1.5 Signatures
8.1.6 Boundary Segments
8.1.7 Skeletons
8.2 Boundary Descriptors
8.2.1 Some Simple Descriptors
8.2.2 Shape Numbers
8.2.3 Fourier Descriptors
8.2.4 Statistical Moments

CHAPTER 9: IMAGE COMPRESSION
9.1 Fundamentals
9.1.1 Coding Redundancy
9.1.2 Spatial and Temporal Redundancy
9.1.3 Irrelevant Information

9.1.4 Measuring Image Information
9.1.5 Fidelity Criteria
9.1.6 Image Compression Models
9.1.7 Image Formats, Containers, and Compression Standards
9.2 Some Basic Compression Methods
9.2.1 Huffman Coding
9.2.2 Golomb Coding
9.2.3 Arithmetic Coding
9.2.4 LZW Coding
9.2.5 Run-Length Coding
9.2.6 Symbol-Based Coding
9.2.7 Bit-Plane Coding
9.2.8 Block Transform Coding
9.2.9 Predictive Coding
9.2.10 Wavelet Coding
9.3 Digital Image Watermarking

13. Lab works

7 x 3-hour lab

14. References

1. "*Digital Image Processing***"** *3rd Edition* – Rafael C. Gonzalez, Richard E. Woods – Prentice Hall, ISBN: 9780131687288
2. "*Digital Image Processing using Matlab***"** – Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins – Prentice Hall, ISBN: 978-0130085191
3. "*Introduction to Digital Image Processing with MATLAB"* – Alasdair McAndrew – Course Technology, ISBN: 978-0534400118
4. *"Digital Image Processing Algorithms and Applications"* – Ioannis Pitas – Wiley-Interscience, ISBN: 978-0471377399
5. *"Digital Signal and Image Processing Using MATLAB"* – Gerard Blanchet, Maurice Charbit – ISTE Publishing Company, ISBN: 978-1905209132
6. *"The Image Processing Handbook" 5th Edition* – John C. Russ – CRC, ISBN: 978-0849372544
7. *"Handbook of Image and Video Processing" 2nd Edition* – Alan C. Bovik - Academic Press, ISBN: 978-0121197926

Chairman of the Scientific and Education Council

ET4576 Computers in Medicine

1. Course Title: **Computers in Medicine**

2. Course ID: ET4576

3. Course Units: **3(2-1-1-6)**

- Lecture: 30 hours
- Seminar: 15 hours
- Lab: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: fundamentals of linear system theory. Fourier and Laplace transforms. fundamentals of computer programming

6. Requisites

- Prerequisites: - ET3006, ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

Integration of materials from prior analog and digital coursework into a course demonstrating design of microcomputer-based medical instrumentation with a focus on techniques for biomedical digital signal processing.

8. Description

Study of microprocessor-based medical instrumentation. Emphasis on real-time analysis of electrocardiograms. Labs and programming project involve design of biomedical digital signal processing algorithms

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Labs: 30%
- Mid-term: 35%
- Final exam: 35%

11. Course Materials

- *"Biomedical Digital Signal Processing: C Language Examples and Laboratory Experiments for the IBM PC"* – Willis J. Tompkins – Prentice Hall, ISBN: 978-0130672162

12. Course Topics

COMPUTERS IN MEDICINE

Course Developer:

CHAPTER 1: INTRODUCTION TO COMPUTERS IN MEDICINE

1.1 Characteristics of medical data
1.2 What is a medical instrument?
1.3 Iterative definition of medicine
1.4 Evolution of microprocessor-based systems
1.5 The microcomputer-based medical instrument
1.6 Software design of digital filters
1.7 A look to the future
1.8 Study questions

CHAPTER 2: ELECTROCARDIOGRAPHY

2.1 Basic electrocardiography
2.2 ECG lead systems
2.3 ECG signal characteristics
2.4 Study questions

CHAPTER 3: SIGNAL CONVERSION

3.1 Sampling basics
3.2 Simple signal conversion systems
3.3 Conversion requirements for biomedical signals
3.4 Signal conversion circuits
3.5 Study questions

CHAPTER 4: BASICS OF DIGITAL FILTERING

4.1 Digital filters
4.2 The *z* transform
4.3 Elements of a digital filter
4.4 Types of digital filters
4.5 Transfer function of a difference equation
4.6 The *z*-plane pole-zero plot
4.7 The rubber membrane concept
4.8 Study questions

CHAPTER 5: FINITE IMPULSE RESPONSE FILTERS

5.1 Characteristics of FIR filters
5.2 Smoothing filters
5.3 Notch filters
5.4 Derivatives
5.5 Window design
5.6 Frequency sampling
5.7 Minimax design

5.8 Study questions

CHAPTER 6: INFINITE IMPULSE RESPONSE FILTERS
6.1 Generic equations of IIR filters
6.2 Simple one-pole example
6.3 Integrators
6.4 Design methods for two-pole filters
6.5 Study questions

CHAPTER 7: INTEGER FILTERS
7.1 Basic design concept
7.2 Low-pass integer filters
7.3 High-pass integer filters
7.4 Bandpass and band-reject integer filters
7.5 The effect of filter cascades
7.6 Other fast-operating design techniques
7.7 Design examples and tools
7.8 Study questions

CHAPTER 8: OTHER TIME- AND FREQUENCY-DOMAIN TECHNIQUES
8.1 The Fourier transform
8.2 Correlation
8.3 Convolution
8.4 Power spectrum estimation
8.5 Study questions

CHAPTER 9: ECG QRS DETECTION
9.1 Power spectrum of the ECG
9.2 Bandpass filtering techniques
9.3 Differentiation techniques
9.4 Template matching techniques
9.5 A QRS detection algorithm
9.6 Study questions

CHAPTER 10: ADAPTIVE FILTERS
10.1 Principal noise canceler model
10.2 60-Hz adaptive canceling using a sine wave model
10.3 Other applications of adaptive filtering
10.4 Study questions

CHAPTER 11: SIGNAL AVERAGING
11.1 Basics of signal averaging
11.2 Signal averaging as a digital filter
11.3 A typical averager
11.4 Software for signal averaging

11.5 Limitations of signal averaging
11.6 Study questions

CHAPTER 12: DATA REDUCTION TECHNIQUES
12.1 Turning point algorithm
12.2 AZTEC algorithm
12.3 Fan algorithm
12.4 Huffman coding
12.5 Study questions

CHAPTER 13: ECG ANALYSIS SYSTEMS
13.1 ECG interpretation
13.2 ST-segment analyzer
13.3 Portable arrhythmia monitor
13.5 Study questions

13. Lab works

8 x 3-hour lab

14. References

1. *"Biomedical Digital Signal Processing: C Language Examples and Laboratory Experiments for the IBM PC"* – Willis J. Tompkins – Prentice Hall, ISBN: 978-0130672162
2. *"Biomedical Signal Processing: Devices, Methods, and Experimentation"* – Eric Wade and John Enderle – Wiley-Interscience, ISBN: 978-1598295535.
3. *"Time Frequency and Wavelets in Biomedical Signal Processing"* - Metin Akay – Wiley-IEEE Press, ISBN: 978-0780311473
4. *"Biomedical Signal Processing and Signal Modeling"* – Eugene N. Bruce – Wiley-Interscience, ASIN: B000VNZRNQ.
5. *"Biomedical Signal Processing"* – Metin Akay – Academic Press, ISBN: 978-0120471454.
6. *"Biomedical Signal and Image Processing"* – Kayvan Najarian and Robert Splinter – CRC, ISBN: 978-0849320996.

Chairman of the Scientific and Education Council

ET4586 Mathematical and Computer Modelling of Physiological Systems

1. Course Title: **Mathematical and Computer Modelling of Physiological Systems**

2. Course ID: ET4586

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: Basic classical physics. Formulate and interprete differential equations. Laplace transforms. Solve simple electric circuits. Basic knowledge of anatomy and physiology. Basic algebriac programming

6. Requisites

- Prerequisites: - ET4456, ET3016
- Corequisites: -

7. Objectives and Expected Outcomes

- To appreciate the value and application of physiological models
- To understand the physiology of some vital organs
- To understand the process of modeling dynamically varying physiological system
- To understand methods and techniques to analyze and synthesize dynamic models
- To develop differential equations to describe the dynamic behavior of physiological systems
- To simulate and visualize dynamic responses of physiological models using computers
- To define and implement physiological models for education, research and product development
- To solve and implement a modeling and design problem from inception to completion

8. Description

Mathematical and computer modeling of physiological systems; principal emphasis on cardiovascular system and individual nerve cells; other topics include respiratory system and skeletal-muscle system; extensive use of "hands-on" computer modeling using ACSL

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 10%
- Projects: 30%
- Mid-terms: 30%
- Final exam: 30%

11. Course Materials

- "*Mathematical and Computer Modeling of Physiological Systems*" - Vincent C. Rideout – Prentice Hall, ISBN: 978-0135633540

12. Course Topics

MATHEMATICAL AND COMPUTER MODELING OF PHYSIOLOGICAL SYSTEMS

Course Developer:

Chapter 1: Introduction

1.1 System Analysis and Modeling
- 1.1.1 Distributed-Parameter Model
- 1.1.2 Lumped-Parameter Model

1.2 Physiological Models
- 1.2.1 Linear Model
- 1.2.2 Nonlinear Model

Chapter 2: Approach and Tools of Physiological System Modeling

2.1 The Need for Models
2.2 Approaches Modeling
2.3 Simulation
2.4 Model Identification
2.5 Model Validation
2.6 Computer Sumulation Programming
- 2.6.1 Matlab Simulink
- 2.6.2 ASCL Programming

Chapter 3: Introduction to Compartment Modeling

3.1 Fluid transport
3.2 Mass Transport by Fluid Flow - Dye Dilution Modeling
3.3 Mass Transport by Flow with Diffusion and Clearance

Chapter 4: The Heart and Circulation

3.1 Plan of the Circulation
4.2 Volume, Flow and Pressure
4.3 Resistance and Compliance Vessels
4.4 The Heart as a Pair of Pump
4.5 Mathematical Model of the Uncontrolled Circulation
4.6 Balancing the Two Sides of the Heart and Two Side Circulations
4.7 The Need for External Circulatory Control Mechanisms
4.8 Neural Control: Baroreceptor Loop
4.9 Autoregulation
4.10 Changes in Circulation Occurring at Birth
4.11 Dynamics of the Arterial Pulse
4.12 Computer Simulation of Pulsatile Blood Flow
4.13 Suggestions for Computing Projects Concerning the Circulation

Chapter 5: Modeling Flow and Pressure in the Systemic Arteries

5.1 Introduction

5.2 Structure of the Large Arteries
5.2.1 Geometric Properties of the Large Arteries
5.2.2 Strutural Properties of the Vessel Walls
5.3 Structure of the Small Arteries
5.3.1 Radius and Asymmetry Relations
5.3.2 Order of the Structure Tree
5.3.3 Length of Segments
5.3.4 Wall Thickness and Young Modulus
5.4 Fluid Dynamic Model of a Large Artery
5.4.1 Momentum and Continuity Equations
5.4.2 State Equation
5.5 Flow and Pressure in the Tree of Large Arteries
5.5.1 Inflow Condition
5.5.2 Bifurcation Condition
5.5.3 Outflow Condition
5.6 Fluid Dynamic Model of a Small Artery
5.7 Impedence at the Root of the Structure Tree

Chapter 6: Gas Exchange in the Lungs
6.1 The Ideal Gas Law and the Solubility of Gases
6.2 The Equation of Gas Transport in One Alveolus
6.3 Gas Transport in the Lung
6.4 Optimal Gas Transport
6.5 Mean Alveolar and Arterial Partial Pressures
6.6 Transport of O2
6.7 Models of Gas Exchange in the Lungs
6.7.1 Models of Diffusion Limitation
6.7.2 Models of Ventilation Perfusion Mismatch
6.8 Computer Solution of the Equations for O2 Transport in the Lung
6.9 Computing Projects Concerning Oxygen Transport

Chapter 7: Models of Respiratory Mechanics
7.1 Introduction
7.2 Breathing Mechanics: Basic Concepts
7.3 First-Order Models
7.4 Second-Order Models
7.5 Respiratory Oscillation Mechanics
7.6 Simulation Modes of Breathing Mechanics

Chapter 8: Multiple modeling
8.1 Introduction to Multiple Modeling of Transport in Arterial Systems
8.2 Multiple Model of Congenital Heart Failures
8.3 Modeling the CO2 Transport in the Bain Circuit
8.4 Uptake and Distribution Models

8.5 Interactive Large-Scale Multiple Model

Chapter 9: Control of Cell Volume and Electrical Properties of Cell Membranes

9.1 Osmotic Pressure and the Work of Concentration
9.2 A Simple Model for Cell Volume Control
9.3 The Movement of Ions Across Cell Membranes
9.4 The Interactions of Electrical and Osmotic Effects
9.5 The Hodkin-Huxley Equation for Nerve Action Potential
9.6 Computer Simulation of the Nerve Action Potential
9.7 Computing Projects Concerning Nerve Impulse

Chapter 10: Muscle Mechanisms

10.1 The Force-Velocity Curve
10.2 Crossbridge Dynamics
10.3 Computer Simulation of Crossbridge Attachment and Detachment
10.4 Suggested Computing Projects on Crossbridge Dynamics

13. Lab works

14. References

1. "*Mathematical and Computer Modeling of Physiological Systems*" - Vincent C. Rideout – Prentice Hall, ISBN: 978-0135633540
2. "*Physiological Control Systems: Analysis, Simulation and Estimation*" - Michael C. K. Khoo – Wiley-IEEE Press, ISBN: 978-0780334083
3. "*Modeling and Simulation in Medicine and the Life Sciences" 2nd Edition* – Frank C. Hoppensteadt, Charles S. Peskin – Springer, ISBN: 978-0387950723
4. "*Modeling Methodology for Physiology and Medicine"* – Ewart Carson, Claudio Cobelli, Joseph Bronzino – Academic Press, ISBN: 978-0121602451.
5. "*Introduction to Modeling in Physiology and Medicine"* – Claudio Cobelli, Ewart Carson – Academic Press, ISBN: 978-0121602406
6. "*Mathematical Modelling in Medicine"* – J.T., Ottesen and M., Danielsen – IOS Press, ISBN: 978-1586030261

Chairman of the Scientific and Education Council

ET4596 Introduction to Bioinformatics

1. Course Title: **Introduction to Bioinformatics**

2. Course ID: ET4596

3. Course Units: **3(3-1-0-6)**

- Lecture: 45 hours
- Seminar: 15 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants:.

6. Requisites

- Prerequisites: - MI1026, ET3166
- Corequisites: -

7. Objectives and Expected Outcomes

- Algorithms for computational problems in molecular biology. The course will study algorithms for problems such as: genome sequencing and mapping, pairwise and multiple sequence alignment, modeling sequence classes and features, phylogenetic tree construction, and gene-expression data analysis

8. Description

Algorithms for computational problems in molecular biology. The course will study algorithms for problems such as: genome sequencing and mapping, pairwise and multiple sequence alignment, modeling sequence classes and features, phylogenetic tree construction, and gene-expression data analysis

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Homeworks: 30%
- Mid-term: 30%
- Final exam: 40%

11. Course Materials

- *"Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic"* – Richard Durbin, Sean R. Eddy, Anders Krogh and Graeme Mitchison – Cambridge University Press, ISBN: 978-0521629713

12. Course Topics

INTRODUCTION TO BIOINFORMATICS

Course Developer:

Chapter 1: Introduction

1.1 Overview of the Book
1.2 Sequence Similarity, Homology and Alignment
1.3 Probabilities and Probabilistic Models
1.4 Further Reading

Chapter 2: Pairwise Alignment

2.1 Introduction
2.2 The Scoring Model
2.3 Alignment Algorithms
2.4 Dynamic Programming with More Complex Models
2.5 Heuristic Alignment Algorithms
2.6 Linear Space Alignment
2.7 Significance of Scores
2.8 Deriving Score Parameters from Alignment Data
2.9 Further Reading

Chapter 3: Markov Chains and Hidden Markov Models

3.1 Markov Chains
3.2 Hidden Markov Models
3.3 Parameter Estimation for HMMs
3.4 HMM Model Structure
3.5 More Complex Markov Chains
3.6 Numerical Stability of HMM Algorithm
3.7 Further Reading

Chapter 4: Pairwise Alignment using HMMs

4.1 Pair HMMs
4.2 The Full Probability of x and y, Summing Over All Paths
4.3 Suboptional Alignment
4.4 The Posterior Probability that x_i is aligned to y_i
4.5 Pair HMMs versus FSA for Searching
4.6 Further Reading

Chapter 5: Profile HMMs for Sequence Families

5.1 Ungapped Score Matrices
5.2 Addin Insert and Delete States to Obtain Profile HMMs
5.3 Deriving Profile HMMs from Multiple Alignment
5.4 Searching with Profile HMMs
5.5 Profile HMM Variant for Non-global Alignments
5.6 More on Estimation of Probabilities

5.7 Optimal Model Construction
5.8 Weighting Training Sequences
5.9 Further Reading

Chapter 6: Multiple Sequence Alignment Methods
6.1 What a Multiple Alignment Means
6.2 Scoring a Multiple Alignment
6.3 Multidimensional Dynamic Programming
6.4 Progressive Alignment Methods
6.5 Multiple Alignment by Profile HMM Training
6.6 Further Reading

Chapter 7: Bulding Phylogenetic Trees
7.1 The Tree of Life
7.2 Background on Trees
7.3 Making a Tree from Pairwise Distances
7.4 Parsimony
7.5 Assessing the Trees: The Bootstrap
7.6 Simultaneous Alignment and Phylogeny
7.7 Further Reading

Chapter 8: Probabilistic Approaches to Phylogeny
8.1 Introduction
8.2 Probabilistic Models of Evolution
8.3 Calculating the Likelihood for Ungapped Alignment
8.4 Using the Likelihood for Inference
8.5 Toward more Realistic Evolutionary Models
8.6 Comparision of Probabilistic and Non-probabilistic Methods
8.7 Further Reading

Chapter 9: Transformational Grammars
9.1 Transformational Grammars
9.2 Regular Grammars
9.3 Context-free Grammars
9.4 Context-sensitive Grammars
9.5 Stochastic Grammars
9.6 Stochastic Context-free Grammars for Sequence Modelling
9.7 Further Reading

Chapter 10: RNA Structure Analysis
10.1 RNA
10.2 RNA Secondary Structure Prediction
10.3 Covariance Models: SCFG-base RNA Profile
10.4 Further Reading

Chapter 11: Background on Probability

11.1 Probability Distribution
11.2 Entropy
11.3 Inference
11.4 Sampling
11.5 Estimation of Probabilities from Counts
11.6 The EM Algorithm

13. Lab works

14. References

1. *"Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic"* – Richard Durbin, Sean R. Eddy, Anders Krogh and Graeme Mitchison – Cambridge University Press, ISBN: 978-0521629713
2. *"Introduction to Bioinformatics"* - Arthur M. Lesk - Oxford University Press, ISBN: 978-0199251964
3. *"An Introduction to Bioinformatics Algorithms"* - Neil C. Jones, Pavel Pevzner - MIT Press, ISBN: 978-0262101066
4. *"Introduction to Bioinformatics"* - Teresa Attwood, David Parry-Smith **–** Benjamin Cummings, ISBN: 978-0582327887
5. *"Introduction to Bioinformatics: A Theoretical and Practical Approach"* – Stephen A. Krawetz, David D. Womble – Humana Press, ISBN: 978-1588292414
6. *"Bioinformatics Biocomputing and Perl: An Introduction to Bioinformatics Computing Skills and Practice"* - Michael Moorhouse, Paul Barry - Wiley, ISBN: 978-0470853313

Chairman of the Scientific and Education Council

ET5026 Biomedical Engineering Capstone Design

1. Course Title: **Biomedical Engineering Capstone Design**

2. Course ID: ET5026

3. Course Units: **4(0-0-8-16)**

- Lecture: 00 hours
- Seminar: 00 hours
- Lab: 60 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: At least five semesters of experience with the design process

6. Requisites

- Prerequisites: -
- Corequisites: - ET5028

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.

12. Course Topics

BIOMEDICAL ENGINEERING CAPSTONE DESIGN

Course Developer:

Chapter 1. Project titles in Bioinstrumentation

1.1 Mouth guard for prevention of bruxism
1.2 Heating stage for bioscanner
1.3 Hardware and software development for analysis of blood pressure and blood volume data
1.4 Temperature measurement device for football helmets
1.5 Otoscope video display
1.6 A method for making measurements from video images of the larynx
1.7 A timing device for a strobe light to help find the frequency of vocal cord vibration
1.8 Tongue pressure sensor system (tongue)
1.9 Biofeedback/stress management (EEG_biofeedback)
1.10 Nicolet Biomedical Project: Epilepsy monitor (epilepsy)
1.11 Device to measure position of mouse head (mouse_head)
1.12 Bladder contraction detector (bladder)
1.13 Device to measure the stiffness of intact mouse heart (mouse_heart)
1.14 Breast implant pump (implant_pump)
1.15 EMG biofeedback device (EMG_biofeedback)
1.16 An MRI compatible infusion pump (MRI_pump)
1.17 Ohmeda Project: Identification of IV lines (IV_lines)
1.18 Ohmeda Project: Spatial identification of radio frequency identification tags (RFID)
1.19 Esophageal probe for pH and pressure (esophageal_probe)
1.20 Multistream flow-rate controller (multistream)
1.21 Transport cage support for nonhuman primates (cage_support)
1.22 A portable patient training device for lung cancer treatment (training)
1.23 Method of monitoring shoe sole elasticity (running_shoes)
1.24 Robotic image guided biopsy (robotic_biopsy)
1.25 Novel measures of mouse social behaviors (mouse_stress)
1.26 Electromechanical disposable drug delivery system (drug_pump)
1.27 Ergonomic ultrasound probe (sonography)
1.28 A new localization device for breast lesions (localization_device)
1.29 System to accurately and automatically record time stamps on X-ray radiographs
1.30 National Design Competition: Accessible Medication Dispensing Device
1.31 Peak inspiratory and peak expiratory flow meter (flow_meter)
1.32 Fundus reading hood (fundus reading hood)
1.33 Ophthalmic dose compliance monitor (dose_compliance)
1.34 Electromechanical disposable drug delivery system (drug_pump)
1.35 An airway pressure device for use in MRI machine (airway_pressure)
1.36 Warning system for wheelchair (warning_system)
1.37 Biofeedback and stress management (eeg_biofeedback)
1.38 Design of an alternate switch/interface for a portable oral suctioning device
1.39 National Design Competition: Accessible Blood Glucose Monitor Interface

1.40 National Design Competition: Accessible Medication Dispensing Device
1.41 Measurement of pulse transit time (pulse_transit_time)
1.42 Peak inspiratory and peak expiratory flow meter (flow_meter)
1.43 Fundus reading hood
1.44 Ophthalmic dose compliance monitor (dose_compliance)
1.45 Electromechanical disposable drug delivery system (drug_pump)
1.46 An airway pressure device for use in MRI machine (airway_pressure)
1.47 Warning system for wheelchair (warning_system)
1.48 Engineering World Health (EWH) Project: Temperature Tester (temperature_tester)
1.49 Engineering World Health (EWH) Project: Flow Meter (gas_flow_meter)
1.50 Engineering World Health (EWH) Project: Pressure Meter (pressure_meter)
1.51 Device for interfacing a cell phone with a hearing aid (cell_phone_aid)
1.52 Biofeedback and stress management (eeg_biofeedback)
1.53 Design of an alternate switch/interface for a portable oral suctioning device
1.54 Using technology to measure adherence of complicated medication regimens
1.55 Electronic measurement of interrelater reliability in the sleep lab (sleep_studies)
1.56 Periodic measurement of nighttime weight change while asleep (weight_change)
1.57 National Design Competition: Accessible infusion pump interface (infusion_pump)
1.58 Biofeedback and stress management (eeg_biofeedback)
1.59 Engineering World Health (EWH) Project: Phantom for pulse oximeter (oximeter_phantom)
1.60 Engineering World Health (EWH) Project: Pressure meter (pressure_meter)
1.61 Measuring caloric input using chewing sounds (chewing_sounds)
1.62 Measuring caloric consumption by body movement (body_movement)
1.63 A multichannel brain tissue stimulator (brain_stimulator)
1.64 Ophthalmic dose compliance monitor (dose_compliance)
1.65 Glaucoma medication electronic reminder/compliance aid (medication_reminder)
1.66 Adhesive finger probe + LED used to assess blood flow to the finger tip (blood_flow)
1.67 Chamber for measuring oxygen consumption (oxygen_chamber)
1.68 National Design Competition: Accessible home vital signs monitoring system
1.69 Sensory substitution device for hearing impairment (sensory_substitution)
1.70 Measuring caloric input using chewing sounds (chewing_sounds)
1.71 Measuring caloric consumption by body movement (body_movement)
1.72 Engineering World Health (EWH) Projects (up to 3 teams)
1.73 Measuring ventilation from a chest strap (ventilation_monitor)
1.74 Measuring hot flash occurrence using skin color (skin_color_monitor)
1.75 Human respiratory mechanics demonstration model (respiratory_model)
1.76 Portable instrumentation to detect gait instabilities (gait_device)
1.77 Sensory substitution device for hearing impairment (sensory_substitution)
1.78 Field measurement of running impacts (running_impacts)
1.79 Permanently implantable inductive ICP monitor (ICP_monitor)
1.80 Mouth guard for prevention of bruxism (teeth grinding during sleep)
1.81 Device to measure urine sodium and potassium losses in extremely preterm infants
1.82 Hardware and software development for analysis of blood pressure and blood volume data

1.83 Mouth guard for prevention of bruxism
1.84 Tongue pressure sensor system
1.85 Metabolic rate of rhesus monkeys
1.86 A timing device for a strobe light to help find the frequency of vocal cord vibration
1.87 Development of an exhaled breath condensate system for use during exercise (condensate)
1.88 Rapid cell concentration estimate (cell)
1.89 An arthroscopy device to create chondromalacia (arthroscopy)
1.90 Finger switch for electrosurgery (electrosurgery)
1.91 Tongue pressure sensor system (tongue)
1.92 Development of an exhaled breath condensate system for use during exercise (condensate)
1.93 Biofeedback/stress management (EEG_biofeedback)
1.94 Device to measure the stiffness of intact mouse heart (mouse_heart)
1.95 Nicolet Biomedical Project: Epilepsy monitor (epilepsy)
1.96 An MRI compatible infusion pump (MRI_pump)
1.97 A portable patient training device for lung cancer treatment (training)
1.98 "Cherry Picking Guide" for small molecule screening (small_molecule)
1.99 Method of monitoring shoe sole elasticity (running_shoes)
1.100 Eye drop measurement device (eye_drops)
1.101 Eye movement measurement in the MRI (eye_movement)
1.102 Robotic image guided biopsy (robotic_biopsy)
1.103 Probing the experience of pain (pain_probe)
1.104 Temperature controller and solution delivery switch for patch clamp (patch_clamp)
1.105 Assessment of intrapleural pressure changes using novel technology (intrapleural_pressure)
1.106 Gas flow controller (hypoxia)
1.107 Mist generator (mist_generator)
1.108 Use of intravascular ultrasound probe to improve biopsy yield (ultrasound_probe)
1.109 A system for objective measures of patient functions related to quality of life
1.110 Tongue pressure sensor system (tongue)
1.111 Development of an exhaled breath condensate system for use during exercise (condensate)
1.112 Biofeedback/stress management (EEG_biofeedback)
1.113 Device to measure the stiffness of intact mouse heart (mouse_heart)
1.114 Nicolet Biomedical Project: Epilepsy monitor (epilepsy)
1.115 Device to measure position of mouse head (mouse_head)
1.116 EMG biofeedback device (EMG_biofeedback)
1.117 An MRI compatible infusion pump (MRI_pump)
1.118 A portable patient training device for lung cancer treatment (training)
1.119 "Cherry Picking Guide" for small molecule screening (small_molecule)
1.120 Method of monitoring shoe sole elasticity (running_shoes)
1.121 Eye drop measurement device (eye_drops)
1.122 Eye movement measurement in the MRI (eye_movement)
1.123 Robotic image guided biopsy (robotic_biopsy)

1.124 Probing the experience of pain (pain_probe)
1.125 Temperature controller and solution delivery switch for patch clamp (patch_clamp)
1.126 Assessment of intrapleural pressure changes using novel technology (intrapleural_pressure)
1.127 Gas flow controller (hypoxia)
1.128 Mist generator (mist_generator)
1.129 Use of intravascular ultrasound probe to improve biopsy yield (ultrasound_probe)
1.130 A system for objective measures of patient functions related to quality of life
1.131 Ohmeda Project: Spatial identification of radio frequency identification tags (RFID)
1.132 Esophageal probe for pH and pressure (esophageal_probe)
1.133 A portable patient training device for lung cancer treatment (training)
1.134 Method of monitoring shoe sole elasticity (running_shoes)
1.135 Robotic image guided biopsy (robotic_biopsy)
1.136 Ohmeda Project: Identification of IV lines (IV_lines)
1.137 Electromechanical disposable drug delivery system (drug_pump)
1.138 Ergonomic ultrasound probe (sonography)
1.139 System to accurately and automatically record time stamps on X-ray radiographs
1.140 Device to deliver multiple audio services to the elderly
1.141 Engineering World Health (EWH) Projects
1.142 National Design Competition: Accessible Medication Dispensing Device
1.143 An airway pressure device for use in MRI machine (airway_pressure)
1.144 Fundus reading hood (fundus reading hood)
1.145 Ophthalmic dose compliance monitor (dose_compliance)
1.146 Measurement of pulse transit time (pulse_transit_time)
1.147 Engineering World Health (EWH) Project: Temperature Tester (temperature_tester)
1.148 Engineering World Health (EWH) Project: Flow Meter (gas_flow_meter)
1.149 Engineering World Health (EWH) Project: Pressure Meter (pressure_meter)
1.150 Biofeedback and stress management (eeg_biofeedback)
1.151 Secondary video monitor display (display)
1.152 Hands-free manual ventilator (manual_ventilator)
1.153 Telephone access for patient with hearing, voice and mobility impairments
1.154 A multichannel brain tissue stimulator (brain_stimulator)
1.155 Transcranial magnetic stimulation (TMS) positioner (positioner)
1.156 Feedback stimulation to stop seizure activity (feedback_stimulator)
1.157 An electromechanical whole-body rotator for cats (rotator)
1.158 Engineering World Health (EWH) Pressure Meter (pressure_meter)
1.159 Engineering World Health (EWH) Aspirator (aspirator)
1.160 Measuring hot flash occurrence using skin color (skin_color_monitor)
1.161 Measuring ventilation from a chest strap (ventilation_monitor)
1.162 External scaffolding for rapid use of AV fistulas in dialysis patients (fistula_scaffold)
1.163 Instrumented hand exerciser to promote AV fistula maturation in dialysis patients
1.164 Human respiratory mechanics demonstration model (respiratory_model)
1.165 Thermal probe for neurologic exam
1.166 Design of rat metabolic chamber

1.167 Biofeedback machine to teach subjects to relax into meditative states
1.168 Device to measure serum bilirubin
1.169 Portable vocal abuse feedback device
1.170 Portable voice calibrator
1.171 Portable voice amplifier

Chapter 2. Project titles in Biomechanics

2.1 Device to move patient in, out and between beds
2.2 Device for administration of intra-ocular injections
2.3 Nanoindentation fixture to test the modulus of mouse bone
2.4 Improved design for fine-needle aspiration of breast cancer lesions
2.5 Syringe modifications for intervertebral injections
2.6 Portable ventilation system for vertebroplasty polymers
2.7 An improved shipping container for assisted reproduction
2.8 Device for preparation of tissue samples for biochemical analyses
2.9 IV tubing organizer (IV_tubing)
2.10 Modifications of monkey restraint device for administration of topical eye drops
2.11 National Design Competition: Accessible syringe dosing (syringe_dosing)
2.12 National Design Competition: Accessible ergometer (ergometer)
2.13 Bruno project: Operator control pendant (control_pendant)
2.14 An artificial eye for teaching ophthalmoscopy (artificial_eye)
2.15 Robotic arm for minimally invasive surgery (robotic_arm)
2.16 Intermedulary rod for canine fractures (canine_fractures)
2.17 Load for ventricular assist device (VAD_load)
2.18 Face masks for reptiles (face_masks)
2.19 Device for maxillomandibular fixation following facial fractures (fixation)
2.20 National Design Competition: Patient Positioning Aid (positioning_aid)
2.21 A child passenger safety seat (child_seat)
2.22 Canine head positioning system for MR imaging (head_positioning)
2.23 Bruno project: Strap-type docking device for wheelchair lift (Strap_docking)
2.24 Bruno project: C-arm docking device for wheelchair lift (C-arm_docking)
2.25 Bruno project: Operator control pendant (control_pendant)
2.26 Bruno project: Platform lift gate interlock (gate_interlock)
2.27 An artificial eye for teaching ophthalmoscopy (artificial_eye)
2.28 Robotic arm for minimally invasive surgery (robotic_arm)
2.29 Intermedulary rod for canine fractures (canine_fractures)
2.30 Load for ventricular assist device (VAD_load)
2.31 Face masks for reptiles (face_masks)
2.32 Device for maxillomandibular fixation following facial fractures (fixation)
2.33 Adjustable wave tube stand for Acoustic Reflection Technique (ART) (wave_tube_stand)
2.34 Devices for rapid freezing of fruit flies
2.35 Instruments to aid in cleft palate surgery
2.36 Self-disarming suture
2.37 Device for administration of intra-ocular injections

2.38 Variable stiffness guide wire
2.39 Mouth stick to facilitate quadriplegics' use of computer keyboard
2.40 Developing a Blood Sampling Tool for Free-Ranging Whales
2.41 Improved design for fine-needle aspiration of breast cancer lesions
2.42 Syringe modifications for intervertebral injections
2.43 Portable ventilation system for vertebroplasty polymers
2.44 Platform for arm support during radiologic procedures
2.45 An improved shipping container for assisted reproduction
2.46 Device for preparation of tissue samples for biochemical analyses
2.47 Device for administration of intra-ocular injections (intra-ocular)
2.48 Large animal ventilator (ventilator)
2.49 Improved design for fine-needle aspiration of breast cancer lesions (aspiration)
2.50 Syringe modifications for intervertebral injections (intervertebral)
2.51 Portable ventilation system for vertebroplasty polymers
2.52 An improved shipping container for assisted reproduction (container)
2.53 Device for preparation of tissue samples for biochemical analyses
2.54 Measurement of the stability of fatigue cracks in equine subchondral bone (equine)
2.55 Rat milking machine with restraint (milking)
2.56 Ohmeda Project: Automatic Metered Dose Inhalant (MDI) delivery device (MDI)
2.57 A model of CSF flow in the human craniovertertebral junction (CSF_flow)
2.58 Ergonomic ultrasound probe (sonography)
2.59 Holding chamber for zebrafish (zebrafish)
2.60 Add on mixing chamber for mechanical ventilator (mixing_chamber)
2.61 Ohmeda Project: Automatic Metered Dose Inhalant (MDI) delivery device (MDI)
2.62 IV tubing organizer (IV_tubing)
2.63 Modifications of monkey restraint device for administration of topical eye drops
2.64 A model of CSF flow in the human craniovertertebral junction (CSF_flow)
2.65 Ergonomic ultrasound probe (sonography)
2.66 Holding chamber for zebrafish (zebrafish)
2.67 Add on mixing chamber for mechanical ventilator (mixing_chamber)
2.68 National Design Competition: Accessible syringe dosing (syringe_dosing)
2.69 National Design Competition: Accessible ergometer (ergometer)
2.70 Control lever for wheelchair platform lift (control_lever)
2.71 Operator control pendant (control_pendant)
2.72 Securement sytem for wheelchair platform lift (securement_system)
2.73 An artificial eye for teaching ophthalmoscopy (artificial_eye)
2.74 A child passenger safety seat (child_seat)
2.75 National Design Competition: Patient Positioning Aid (positioning_aid)
2.76 Load for ventricular assist device (VAD_load)
2.77 Canine head positioning system for MR imaging (head_positioning)
2.78 Bruno project: Strap-type docking device for wheelchair lift (Strap_docking)
2.79 Bruno project: C-arm docking device for wheelchair lift (C-arm_docking)
2.80 Bruno project: Platform lift gate interlock (gate_interlock)
2.81 Elevator controller for individual with multiple sclerosis (elevator_control)
2.82 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient

2.83 Grasping instrument for minimally invasive laparoscopic bowel surgery
2.84 Retractor for breast surgery (retractor)
2.85 Valve for an endotracheal tube cuff (cuff_valve)
2.86 Ring removal device (ring_remover)
2.87 Device for dilating esophageal strictures (esophageal_strictures)
2.88 System to take retinal pictures of bed or wheelchair confined individuals
2.89 Feeding bottle to limit volume of each swallow
2.90 Device to preserve bone tissue during immobilization
2.91 Oxygen Flow Meter/Regulator
2.92 Inhaler
2.93 Walker
2.94 Door Latches
2.95 Improved Hoyer lift
2.96 Improved means of putting on and taking off clothes
2.97 Hygiene needs of quadriplegics
2.98 Delivery start up profiles of infusion pumps at very low flow rates
2.99 Free floating input device
2.100 Valve for bodily fluid drainage for paralyzed individual
2.101 Devices for thermal control to aid in fruit fly studies
2.102 Mounting system for Doppler ultrasound evaluation of prosthetic heart valves
2.103 Diagnostic for color-blind compatibility in Powerpoint (software)
2.104 Home-based muscle strengthening and control device
2.105 Magnetically compatible device to position breast MR biopsy needle
2.106 Device to automate measurements relating confocal microwave breast imaging
2.107 Device to quantify swallowing behavior
2.108 Device to measure tongue-hard palate contact pressure
2.109 Manual grip strength and fatigue meter
2.110 Cutting force measurement system
2.111 Provision for whole body temperature regulation
2.112 Detection of extra vasation during continuous intravenous infusions
2.113 Burns from electrical leads during MRI
2.114 Bellows position detector to automate closed circuit anesthesia
2.115 Nitric oxide device gas blending
2.116 Nitric oxide device delivery trigger
2.117 Emergency ventilator project
2.118 Measure lung ventilation
2.119 Membrane free direct drive anesthesia machine
2.120 Microwave oven improvement for individuals with disabilities
2.121 Sensor for vestibular feedback system
2.122 Instrumentation to study the startle response in primates
2.123 Temperature control system for perfusion chamber
2.124 High-flow high-pressure gas blender for mechanically ventilated patients
2.125 Human patient simulator for cardiopulmonary resuscitation
2.126 Electromechanical adjunct for cardiopulmonary resuscitation
2.127 Portable computer-aided drug dispenser

2.128 Device to monitor/enhance back exercise
2.129 Device for the presentation of olfactory stimuli to monkeys
2.130 Incubation chamber for microscope
2.131 Barostat to measure esophageal strictures
2.132 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
2.133 Ohmeda Project: Automatic Metered Dose Inhalant (MDI) delivery device
2.134 National Design Competition: Innovations in accessible medical instrumentation
2.135 Instrumented tendon stretching device (tendon)
2.136 Artificial burning limb (burning_limb)
2.137 National Design Competition: Patient Positioning Aid (positioning_aid)
2.138 A child passenger safety seat (child_seat)
2.139 Canine head positioning system for MR imaging (head_positioning)
2.140 Syringe for injectable fillers (syringe)
2.141 Helicopter flight helmet (flight_helmet)
2.142 Syringe for injectable fillers (syringe)
2.143 Valve for an endotracheal tube cuff (cuff_valve)
2.144 Ring removal device (ring_remover)
2.145 Testing system for pressure sensitive cardiovascular catheter (catheter)
2.146 Functional seating design for lumbar puncture procedures (lumbar_puncture)
2.147 Design medical device cart used in various clinical environments (device_cart)
2.148 Motor skills tester (skills_tester)
2.149 Automated animal board for positioning during ocular imaging and photography
2.150 Vocal fold vibration tissue engineering bioreactor (vocal_fold)
2.151 Microsurgical clamp for lightly occluding blood vessels (microsurgical_clamp)
2.152 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
2.153 Feet holder for CT scanners (feet_holder)
2.154 Dynamic leg exercise ergometer (ergometer)
2.155 Grasping instrument for minimally invasive laparoscopic bowel surgery
2.156 Retractor for breast surgery (retractor)
2.157 Enhanced safety and visualization for endoscopic sinus surgery (endoscope_device)
2.158 An auto-suture device for nasal surgery (suture_device)
2.159 Design and fabrication of a rotorod apparatus to study motor coordination in birds
2.160 Laparoscopic banding device (banding_device)
2.161 Optimal strategies to relieve tissue congestion (congestion_device)
2.162 Delivery of inhaled drugs through CPAP (cpap)
2.163 Bioreactor for tissue engineering (bioreactor)
2.164 Umbilical cord model for umbilical vein catheterization training (umbilical)
2.165 Feet holder for CT scanners (feet_holder)
2.166 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
2.167 National Design Competition: Accessible Incontinence Control Device
2.168 Leg ergometer for human exercise blood flow studies (ergometer)
2.169 An auto-suture device for nasal surgery (suture_device)
2.170 Creation of a surgical breast pedicle dissector for breast reduction safety

2.171 Thermal warm/heat probe for neurological examination
2.172 Instrumentation to study the startle response in primates
2.173 Automated Metered-Dose Inhaler Deliver Device
2.174 Experimental Method to Quantify Mosquito Bite Characteristics
2.175 Device to monitor/enhance back exercise
2.176 Device for the presentation of olfactory stimuli to monkeys
2.177 Incubation chamber for microscope
2.178 Barostat to measure esophageal strictures
2.179 Human patient simulator for cardiopulmonary resuscitation (simulator)
2.180 Electromechanical adjunct for cardiopulmonary resuscitation (resuscitation)
2.181 Portable computer-aided drug dispenser (dispenser)
2.182 Device to monitor/enhance back exercise

Chapter 3. Project titles in Biomaterials
3.1 American Medical Systems Project: Porcine dermis for tissue repair (hair_removal)
3.2 Microencapsulation of tissues and cells for treatment of hormone-related diseases
3.3 Designing porous hydrogels to template biomaterial synthesis (hydrogel_templates)
3.4 Device for converting ELP aggregate to soluable form (ELP_aggregate)
3.5 Application of mechanical stress to hydrogel scaffolds for the study of cardiac hypertrophy
3.6 Designing porous hydrogels to template biomaterial synthesis (hydrogel_templates)
3.7 Device for converting ELP aggregate to soluable form (ELP_aggregate)
3.8 Design of a device for rapid screening of X-ray diffraction characteristics of protein crystals
3.9 Development of non-thrombogenic coatings for devices (hydrogel_coating)
3.10 Interpenetrating networks for delivery systems (interpenetrating_networks)
3.11 Medical prosthetics for plastic surgery (up to 3 teams)
3.12 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
3.13 American Medical Systems Project: Porcine dermis for tissue repair (hair_removal)
3.14 Small diameter centrifuge tube (centrifuge_tube)
3.15 Application of mechanical stress to hydrogel scaffolds for the study of cardiac hypertrophy
3.16 Engineering gradient biomaterials for controlled signaling during stem cell differentiation
3.17 Designing porous hydrogels to template biomaterial synthesis (hydrogel_templates)
3.18 Designing porous hydrogels to template biomaterial synthesis
3.19 Device for converting ELP aggregate to soluable form (ELP_aggregate)
3.20 Design of a device for rapid screening of X-ray diffraction characteristics of protein crystals
3.21 Nonadhesive bioreactor for in vitro cell culture
3.22 Design of a polyethyleneglycol- containing network that minimizes macrophage adhesion
3.23 Optimal design of RF probe for thermal modification of musculoskeletal tissue
3.24 Instruments for pediatric neurosurgery

3.25 Mechanical testing system coupled with an environmental chamber
3.26 Multi-IV fluid feed system
3.27 Growth plate measurement device
3.28 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
3.29 Mechanical testing system coupled with an environmental chamber (chamber)
3.30 An inhalation system for animal infection with BSL3 pathogens (infection)
3.31 Gastric-esophageal reflux disease valve (GERD_valve)

Chapter 4. Project titles in Medical Imaging
4.1 MRI motion phantom
4.2 Mouse rotator for micro-CT scanner
4.3 Head motion detection
4.4 Microscope manipulator for zebrafish analyses (microscope_manipulator)
4.5 A phantom for use in an MR imager (MR_phantom)
4.6 Microscope manipulator for zebrafish analyses (microscope_manipulator)
4.7 An MR surface coil (MR_coil)
4.8 A phantom for use in an MR imager (MR_phantom)
4.9 Stereotactic device compatible with a 1.7 tesla magnetic resonance imaging system

Chapter 5. Project titles in Biocomputing
5.1 Interactive internet-based muscle strengthening and control device
5.2 GE Medical Systems project: develop method to detect quality of ECG signal
5.3 Cable and fluid line management
5.4 Hand hygiene and computerized provider order entry (CPOE)
5.5 Internet-based tools for sensory testing of individuals with degenerative neurological diseases
5.6 GE Medical Systems Project: Develop method to detect quality of ECG signal
5.7 Animated characters
5.8 Computer administered voice questionnaire
5.9 Image analysis systems for geometric analyses in orthopedics
5.10 WebTV user interface for delivery of health care information to patients

Chapter 6. Project titles in All
6.1 Device for dilating esophageal strictures (esophageal_strictures)
6.2 Biological imaging chamber (imaging_chamber)
6.3 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
6.4 Non-metallic algometer to be used in fMRI (algometer)
6.5 Device to improve diagnostic yield of fine needle aspiration (needle_aspiration)
6.6 Steerable device for soft tissue core biopsy or fine needle aspiration (steerable_needle)
6.7 National Design Competition: Accessible power-assist hospital bed back angle controller
6.8 Elevator controller for individual with multiple sclerosis (elevator_control)
6.9 Design of a computer input device for an individual with muscular dystrophy
6.10 Perfusion chamber with removable and flexible porous membrane (perfusion_chamber)

6.11 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device
6.12 National Design Competition: Accessible Weight Scale for Seated Users
6.13 Device for dilating esophageal strictures (esophageal_strictures)
6.14 Biological imaging chamber (imaging_chamber)
6.15 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
6.16 Device to improve diagnostic yield of fine needle aspiration (needle_aspiration)
6.17 Development of outreach program tools for Biomedical Engineering
6.18 Design of a computer input device for an individual with muscular dystrophy

13. Lab works

14. References

1. Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.
2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
3. Moore, J. H., Davis, C. C., and Coplan, M. A. 1989. Building Scientific Apparatus: A Practical Guide to Design and Construction. Addison-Wesley.
4. Pahl, G., Beitz, W. 1988. Engineering Design, A Systematic Approach. London, Springer-Verlag
5. Wilcox, A. 1990. Engineering Design For Electrical Engineers. Englewood Cliffs N.J., Prentice- Hall
6. Ingle, K. A. 1994. Reverse Engineering. New York, McGraw-Hill Inc
7. Carper, K. L. 1989. Forensic Engineering. New York, Elsevier
8. Middendorf, W. H. 1990. Design of Devices and Systems. New York, Marcel Dekker
9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
10. Burgess, J. 1986. Designing for Humans: The Human Factor in Engineering. Princeton, Petrocelli Books
11. Foltz, R., Penn, T. 1989. Protecting Engineering Ideas & Inventions. Cleveland OH, Penn Institute

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ET5028 Biomedical Engineering Design

1. Course Title: **Biomedical Engineering Design**

2. Course ID: ET5028

3. Course Units: **1(0-2-0-2)**

- Lecture: 00 hours
- Seminar: 30 hours

4. Replacement/Equivalent Courses: -

5. Expected Participants: At least four semesters of experience with the design process

6. Requisites

- Prerequisites: -
- Corequisites: - ET4218

7. Objectives and Expected Outcomes

- To develop engineering design skills.
- To cultivate an innovative attitude
- To develop teamwork skills
- To promote a sense of engineering professionalism
- To provide exposure to a wide range of biomedical engineering technology
- To develop communication skills
- To motivate and excite students to achieve a standard of excellence

8. Description

Students will work in a team on a client-centered biomedical engineering design project to learn concept generation, product analysis, specifications, evaluation, clinical trials, regulation, liability, and ethics

9. Student Duties

- Class attendance: ≥ 80%
- Homework:

10. Assessment

- Each student keeps an engineering notebook.
- Each team submits a weekly progress report to their advisor and client by email.
- Each team does a mid-semester PowerPoint presentation and written report.
- Each team produces an end-of-semester final report.
- Each team maintains a web site.
- Each team does an end-of-semester poster presentation.
- Each student does a self and peer performance evaluation

11. Course Materials

- Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley

12. Course Topics

BIOMEDICAL ENGINEERING DESIGN

Course Developer:

Some Project Titles in Biomedical Engineering

1 System for pH measurement inside incubator
2 System to monitor epilepsy in rodents
3 Device to aid communication between intubated patients and care providers
4 Measurement of pulse transit time (pulse_transit_time)
5 DSP application in medical instrumentation (TI_project)
6 Digital Braille watch (braille_watch)
7 Sensory substitution device for hearing impairment (sensory_substitution)
8 Permanently implantable inductive ICP monitor (ICP_monitor)
9 Development of an exhaled breath condensate system for use during exercise (condensate)
10 Medication adherence measurement device (medication_adherence)
11 Delivery of inhaled drugs through CPAP (cpap)
12 Device to assist in removal of pills from bubble wrapped packaging (pill_removal)
13 Leg positioner to facilitate placement of central venous catheters in the ICU
14 Physical 3D model of the larynx with moving parts (larynx_model)
15 Umbilical cord model for umbilical vein catheterization training (umbilical)
16 Neck extender/flexor to facilitate fluoroscopic examination of obtunded patient
17 Assistive device to augment strength in the weak hand of a stroke patient (finger_device)
18 Motorized wheelchair mounting system (wheelchair_mount)
19 National Design Competition: Accessible Incontinence Control Device
20 Method to determine failure in embedded biomaterials (embedded_biomaterials)
21 Mechanical testing system coupled with an environmental chamber
22 Mechanical testing system coupled with an environmental chamber
23 Ohmeda Project: Multi-IV fluid feed system (IV_fluid)
24 Blinking orbital prosthesis (orbital_prosthesis)
25 Device to monitor/control differentiation of stem cells to pancreas (stem_cell_monitor)
26 Design of a heating pad for a microPET/CT scanner (heating_pad)
27 Handheld device to measure tumor size
28 Device to enhance/monitor back exercise
29 Development of optimal design for cooling patients in flight (hypothermia)
30 National Design Competition: Accessible Pill Cap Dispensing/Cutting Device (pill_cap)
31 Device for dilating esophageal strictures (esophageal_strictures)
31 Device for acute rehabilitation of the paretic hand after stroke (hand_rehabilitation)
33 Computer mouse replacement
34 Device for the presentation of olfactory stimuli to monkeys
35 Incubation chamber for microscope (microscope)
36 Multi-IV fluid feed system
37 Mechanical testing system coupled with an environmental chamber (chamber)

38 Ohmeda Project: Portable computer-aided drug dispenser (dispenser)
39 National Design Competition: Innovations in accessible medical instrumentation
40 Artificial burning limb (burning_limb)
41 Syringe for injectable fillers (syringe)
42 Endotracheal tube securing device (endotracheal_device)
4.43 Laparoscopic banding device (banding_device)
44 High speed video system for laryngeal imaging
45 System to study excised larynges
46 Low cost visualization to assist epidural and spinal needle placements
47 Localization of peripheral nerves
48 Minimizing magnetic interference in the MRI environment
49 Measurement device to increase the tactile feedback in regional blocks
50 Output device to increase the tactile feedback in regional blocks
51 Automatic feedback of neuromuscular stimulation in regional block
52 Wireless man-machine communication
53 IV drug project

13. Lab works

14. References

1. Dym, C. L. 2000. Engineering Design: A Project Based Introduction. New York, John Wiley.
2. Webster, J. G. Draft of textbook on design. http://courses.engr.wisc.edu/ecow/get/bme/200/webster/resources/textbookch/
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4. Pahl, G., Beitz, W. 1988. Engineering Design, A Systematic Approach. London, Springer-Verlag
5. Wilcox, A. 1990. Engineering Design For Electrical Engineers. Englewood Cliffs N.J., Prentice- Hall
6. Ingle, K. A. 1994. Reverse Engineering. New York, McGraw-Hill Inc
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8. Middendorf, W. H. 1990. Design of Devices and Systems. New York, Marcel Dekker
9. Sunar, D. G., 1989. The Expert Witness Handbook. Belmont CA, Professional Publications
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