

# BIOMEDICAL ENGINEERING PROGRAM



COURSE SYLLABI

**EE 201 – COMPUTER PROGRAMMING I (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring)

**Bulletin Description:** Introduction to computers. Simple algorithms and flowcharts. Solving engineering and mathematical problems using a mathematically-oriented programming language. Programming concepts: I/O, assignment, conditional loops, functions and subroutines. Programming selected numerical and non-numerical problems of mathematical and engineering nature

**Prerequisites:** Math 101, ELC102

**Textbooks:** William J. Palm III, Introduction to MatLab 7 for Engineers, McGraw-Hill International Edition, 2005

**References:**

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe the basics of Matlab
2. apply Matlab to solve engineering problems
3. describe the fundamentals of programming
4. design simple programs
5. modularize the programs using functions

**Course Topics:**

- 1- Engineering Problems and the Need for Computer Solutions
- 2- Basics of MatLab: Menus – Toolbars – Computing with MatLab – Script Files and the Editor/Debugger – MatLab help System.
- 3- Arrays, Matrices and Matrix Operations.
- 4- User-Defined Functions.
- 5- Working with Data Files.
- 6- Basics of Programming: Algorithms - Pseudo Code - Flow Charts – Programming Structures.
- 7- Program Design and Development.
- 8- Relational Operations and Logical Variables.
- 9- Logical Operators and Functions.
- 10- Conditional Statements: if – else – elseif - switch
- 11- Loops: for – while – break – continue.
- 12- Debugging MatLab Programs.
- 13- Graphing Functions: XY Plots – Sub-Plots
- 14- Introducing Simulink.

**Class Schedule:**

Lecture: There are three hours of lectures per week. You have to attend all lectures.

Tutorials: There are two hours of lab per week, compulsory to attend. You will sign in. Those who miss lab periods, miss points, and also suffer in the Final Exam

**Course Contribution to Professional Component:**

Engineering Science: 75 %

Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	L	H		H						M		H	H			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by:** Drs Alaa Gowdah and Haitham Al-Angari

**Last Updated:** October, 2007

**EE 202 – OBJECT-ORIENTED COMPUTER PROGRAMMING (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Object-oriented programming: classes, objects and methods. Object-oriented design. Simple data structures. Best programming practices (structured coding, documentation, testing and debugging)

**Prerequisites:** EE 201

**Textbooks:** Gary J. Bronson, A First Book of C++, 2<sup>nd</sup> ed Brooks/Cole Publishing Co, 2000.

**References:** Camal Gambi, Problem Solving Using C++, 3<sup>rd</sup> ed. (Arabic), Dar Al Hafiz Publishing, 1997.

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. identify different computer components including new technologies
2. recognize how computer programs work
3. analyze engineering problems
4. breakdown a problem situation into components (input, output, procedure)
5. describe the syntax and semantics of a C++ program
6. choose appropriate input and output methods and formats
7. choose appropriate control structures to account for different cases of input and different levels of accuracy
8. choose the best data type for a solution among simple and derived data types such as arrays, character strings, structures, and classes
9. modularize the programs using functions and classes in C++
10. design algorithms to solve scientific and engineering problems using computers
11. design and implement object-oriented programs

**Course Topics:**

1. Review basic computer information covered by level I
2. C++ program structure and data types and their operations
3. Input and Output functions
4. Assignment and Interactive input
5. Selection using if-else, nested if, and switch
6. Repetition using while, for, and do statements
7. Arrays including one dimensional and 2-dimensional arrays
8. Pointers and character strings
9. Functions, and their arguments
10. Structures and their applications
11. C++ classes and objects
12. Inheritance
13. Recursion
14. Simple algorithms (searching and sorting)

- 15. Testing and debugging
- 16. Documenting

**Class Schedule:**

Lecture: Two 75-minute lectures for 14 weeks  
 Tutorials: One two hours lab/tutorial every week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	M	H		H				L		M		H	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Ali H. Morfeg**

**Last Updated: October, 2007**

**EE 250 – BASIC ELECTRICAL CIRCUITS (4,3,2) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Electric quantities and circuit elements. Kirchhoff's laws. Mesh and node analyses. Sinusoidal steady-state analysis using phasors. Network theorem and transformations. Ideal transformers. Three-phase circuits.

**Prerequisites:** PHYS 102, ELC 102

**Textbooks:** Alexander "Fundamentals of electric circuits", Second edition

**References:** Course website : <http://engg.kau.edu.sa/~aabdulwhab/ee250/>

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. understand fundamental electric quantities: voltage, current, electric power and energy.
2. identify the difference between dependant and independent voltage and current sources.
3. analyze and evaluate responses of circuits containing resistance, capacitance and inductance elements according to fundamental circuit laws.
4. calculate the currents and voltages in resistive circuits using Ohm's law, KCL, KVL, reduction of series and parallel resistances, and voltage and current divisions
5. find the node voltages in resistive circuits containing current sources and voltage sources using nodal analysis
6. find the mesh currents and branch currents in resistive circuits containing voltage sources and current sources using mesh analysis
7. analyze resistive circuits containing multiple sources by using superposition
8. apply Thevenin's and Norton's theorems to simplify a resistive circuit by finding the Thevenin or Norton equivalent of a two-terminal network
9. apply KVL, KCL, nodal and mesh analysis to circuits containing dependent sources.
10. apply the source transformation and Y- $\Delta$  transformation to simplify circuits.
11. evaluate maximum power transfer to a variable load resistance.
12. understand time varying voltage and current and appreciate sinusoidal signals in AC circuits.
13. evaluate effective or rms values of AC voltages and currents.
14. find the phasor voltage (current) for a given sinusoidal voltage (current), and find the sinusoidal voltage (current) for given phasor voltage (current) and frequency.
15. find the impedances of resistors, capacitors, and inductors for a given frequency
16. convert an AC steady-state circuit to a phasor circuit
17. analyze a phasor circuit using Ohm's law, KCL, KVL, reduction of series and parallel impedances, and voltage and current divisions
18. calculate AC steady-state power dissipated by the circuit elements in a circuit
19. understand the concepts of power factor, complex power, and conservation of power.
20. solve single and three phase circuits using VA method for the real, reactive and complex power supplied by, or consumed by any device in the circuit; and use reactive compensation for power factor improvement.
21. solve simple three-phase circuits to calculate any system voltage, current or power.
22. understand and be able to use per phase analysis to solve simple three-phase systems.
23. derive the voltage and current relationships for an ideal transformer.
24. work with a small team to carry out experiments in electric circuits and prepare reports that present lab work.

**Course Topics:**

EE 250	Topics	Time (week)
TOP 1	Fundamental electric quantities: voltage, current	0.25
TOP 2	Electric power and energy	0.25
TOP 3	Independent and dependant sources	0.5
TOP 4	Resistance, capacitance and inductance	0.67
TOP 5	Kirchhoff's laws (KVL & KCL)	0.67
TOP 6	Source equivalence and conversion	0.67
TOP 7	Mesh current (loop) analysis	1
TOP 8	Node voltage analysis	1
TOP 9	Super-position theorem	0.5
TOP 10	$\Delta/Y$ transformation	0.5
TOP 11	Thevenin's and Norton's theorems	1
TOP 12	Sinusoidal excitation, average and effective values	1
TOP 13	Complex numbers	1
TOP 14	Steady state a.c. circuit and impedance	1
TOP 15	Phasor diagrams	1
TOP 16	Maximum power transfer theorem	1
TOP 17	Power triangle and power factor correction	1
TOP 18	Balanced three phase circuits	1
TOP 19	Power measurement in three phase circuits	1
TOP 20	Ideal transformer	1

#### Class Schedule:

Lecture: There will be about three 50 minutes lectures per week. During the lectures, There might be a 5-minute pop quiz. Students may be asked to participate and answer questions

Tutorials: Students are highly encouraged to attend the tutorial sessions to practice solving practical problems. Lab attendance and participation is mandatory

#### Course Contribution to Professional Component:

Engineering Science: 85 %

Engineering Design: 15 %

#### Course Relationship to Program Outcomes:

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	L		M	M		M		L	L	M		M	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

Prepared by: Dr. Abdulaziz Uthman Al-Abdulaziz

Last Updated: October 2007

**EE 253 – ELECTRICAL AND ELECTRONIC MEASUREMENTS (4,3,3) 4 Credits**  
**(Core course offered in Fall and Spring terms)**

**Bulletin Description:** The course provides students with a back ground in electrical and electronic measurements and instrumentation. Terms related to electrical measurements are investigated. The function elements of a general measuring instrument, sources of error, and methods of error analysis are introduced. Principles, limitations, and applications of oscilloscopes, analog DC and AC ammeters and voltmeters will be studied. Ohmmeters, DC and AC bridges are analyzed. Power and reactive power measurements are covered. Electronic and digital measurement systems will also be given some consideration.

**Prerequisites:** EE301, IE331 (Concurrent)

**Textbooks:** A.K. Sawhney, " A Course in Electrical and Electronic Measurements and Instrumentation", DHANPAT RAI, Seventeenth Edition, 2004

**References:** Martin U, Reissland, Electrical Measurements: Fundamentals, Concepts, and Applications, New Age International Publishers, New Delhi, 2003

### **Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe the instrument functions and define terms related to electrical measurements
2. demonstrate the different stages of the generalized measurement system
3. illustrate the error sources in measurements
4. apply statistical analysis of errors
5. calculate the probable and limiting errors
6. apply mathematical analysis of the uncertainty
7. demonstrate a practical representation of a general purpose cathode ray tube (CRT)
8. illustrate a block diagram of a basic oscilloscope and label each block
9. demonstrate the functions of the following: vertical amplifier, horizontal amplifier, sweep generators, and trigger circuit
10. distinguish the basic principle of operation of the dual trace oscilloscope
11. apply the oscilloscope to measure: the frequency and amplitude of a signal, the phase-shift between signals
12. identify the operation controls of a triggered oscilloscope and adjust the control
13. operate DC and AC voltage and frequency measurements with the oscilloscope
14. operate frequency and phase difference measurements using Lissajous patterns
15. classify the analog instruments
16. illustrate the functions and methods of producing the following forces: deflecting, controlling, and damping force
17. demonstrate principle of operation, construction, torque equations, temperature effect correction, loading effects, errors, and applications of the following instruments: permanent magnet moving coil, series type and shunt type ohmmeters
18. propose an Ayrton shunt across a meter movement to obtain specific meter readings of current
19. propose multipliers or shunts to obtain specific meter ranges of voltage and current
20. demonstrate construction, principle of operation, limitations, waveform error, and applications of a half-wave and full-wave rectifier type meters
21. investigate the principle of operation, frequency range, torque equation, errors, and applications of: moving iron meter, electro-dynamometer, and single phase electro-dynamometer wattmeter
22. employ instrument transformers in power measurements
23. carry out measurements of power in three phase circuits using: three-wattmeter's method, two-wattmeter's method, one wattmeter method, three-phase wattmeter



24. operate measurements of reactive power in single phase and three-phase circuits
25. analyze and indicate the applications of: Maxwell's inductance bridge, Maxwell's inductance capacitance bridge, Hay's bridge, Modified De Sauty's bridge, Heaviside mutual inductance bridge, Wien's bridge, Universal bridge
26. summarize sources of error in bridge circuits
27. Illustrate the advantages of an electronic measuring instruments
28. demonstrate principle of operation and applications of: the voltage attenuator, the current to voltage converter, the ac to dc converter, the resistance to voltage converter, peak and average detectors, and true rms value detector
29. illustrate the advantages of digital instruments
30. demonstrate principle operations and constructions of : A/D converter (ramp type), the decade counter, digital display units (7-segmental display), the decoder
31. illustrate organization, principle of operation, and applications of digital voltmeter
32. prepare and design experimental measurements of: dc voltage and current, ac voltage and current indicating waveform errors, resistance and power measurements
33. demonstrate effective teamwork both in planning and in carrying out experimental activities
34. prepare an engineering report that presents and analyzes laboratory work

### Course Topics

EE 253	Topics	Time (Hrs)
TOP 1	Fundamental Measurement Concepts: terms related to electrical measurements, generalized measurement system, sources of errors, statistical analysis of errors, and uncertainty analysis.	6
TOP 2	Cathode Ray Oscilloscope: construction, principle of operation, and applications.	6
TOP 3	Analog instruments: principle of operation, types, and operating forces.	3
TOP 4	DC instruments: construction, principle of operation, torque equation, extension of range, Loading effects, temperature effect correction, limitation, errors, and applications of : (a) Permanent magnet moving coil. (b) Series and shunt type ohmmeters.	7
TOP 5	AC instruments: construction, torque equation, extension of range, limitations, and applications of: (a) rectifier type. (b) moving iron. And (c) electro-dynamometer type.	7
TOP 6	Measurement of power and reactive power in single-phase and three-phase circuits.	4
TOP 7	DC and AC Bridges.	3
TOP 8	Electronic instruments: attenuators, electronic converters and detectors.	3
TOP 9	Digital instruments: digital versus analog instruments, analog-to- digital ramp type conversion, decade counter, digital display units, and digital voltmeter	5
TOP 10	Lab activities	9
TOP 11	Project	0

**Class Schedule:** Lecture: Two one and a half hours sessions per week

Tutorials/Lab: one two hours lab and one-hour tutorial sessions per week

### Course Contribution to Professional Component:

Engineering Science: 100 % ; Engineering Design: %

### Course Relationship to Program Outcomes:

P Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Av. attainable level of learning (*)	M	M		M	M	M	M	M			M	M	M				

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

Prepared by: Dr. Ahmed Milyani

Last Updated: October 2007

**EE 300 – ANALYTICAL METHODS IN ENGINEERING (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Linear algebra: matrices and determinants, eigenvalues and eigenvectors. Complex analysis: integration in the complex plane and residue analysis. Graphs, fundamental loops, fundamental cutsets.

**Prerequisites:** MATH 203

**Textbooks:** E. Kreyzig, Advanced Engineering Mathematics, 9<sup>th</sup> Ed, Wiley, 2006

**References:**

1. D. Zill and P. Shanahan, Complex Analysis, Jones and Bartlett, 2003.
2. F. Ayres, Matrices, McGraw-Hill, 1974.
3. W. Chen, Applied Graph Theory, North-Holland, 1976

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. understand the concept of scalars, vectors, and matrices
2. understand and construct simple mathematical proofs that are of engineering utility
3. recognize and handle some important classes of matrices: symmetric, ske-symmetric, involutory, idempotent, nilpotent, orthogonal, and orthonormal
4. recognize the linear dependency and independency of vectors
5. determine the existence of a square matrix inverse
6. calculate the matrix inverse using Gauss-Elimination method, the Gauss-Jordan method and the Cofactor method
7. solve linear equations using Gauss-Elimination method and Cramer's rule
8. understand the concept of graphs and directed graphs
9. apply the graph theory to obtain and relate the reduced incidence matrix, the fundamental cutset matrix, and the fundamental loop matrix, based on a specific choice of datum (reference) node and spanning tree.
10. write KCL and KVL for a given directed graph and express tree currents in terms of link currents and link voltages in terms of tree voltages
11. manipulate complex numbers in different basic mathematical operations
12. compute function values of complex variables
13. differentiate and integrate complex variable functions
14. understand the geometry of analytic functions and conformal mapping
15. manipulate various types of series: power, Taylor, and Laurent
16. apply Cauchy integration formula and residual theorem
17. use contour integration to evaluate real improper integrals

18. compute matrix eigenvalues and their associated eigenvectors and eigenspaces
19. apply the fundamental concepts of matrix eigenvalues in practical problems

**Course Topics:**

1. Complex numbers and operations
2. Special complex functions
3. Complex derivatives and conformal mapping
4. Various types of series: power, Taylor, and Laurent
5. Integration in the complex plane
6. Residue integration and it's applications
7. Introduction to linear algebra and vector spaces
8. Basic concepts, properties, and algorithms of matrices, their inverses and determinants
9. Eigenvalues and eigenvectors and their applications
10. Introduction to graph theory

**Class Schedule:**

Lecture: three one-hour or two one-and-a half-hour lectures per week

Tutorials: one 2-hour tutorial per week

**Course Contribution to Professional Component:**

Engineering Science: 90%

Engineering Design: 10%

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M				M								M	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Prof. Dr. Ali Muhammad Rushdi**

**Last Updated: October, 2007**

**EE 301 – ELECTRICAL CIRCUITS AND SYSTEMS (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Resonance circuits. Magnetically-coupled circuits. Op-amp circuits. Transient analysis via the conventional and Laplace methods. Fourier analysis with applications to circuits. Two-port networks.

**Prerequisites:** MATH 204 , EE 250

**Textbooks:** C. K. Alexander & M. N. Sadiqu, Fundamentals of Electric Circuits, 2nd ed., McGraw-Hill, 2004

**References:**

- 1) J. W Nilsson & S. Radio, Electric Circuits, 6th ed., Addison Wesley, 2001.
- 2) R. Strum & J. Ward, Electric Circuits and Networks, 2nd ed., Prentice Hall, 1985.
- 3) C. Paul, Analysis of Linear Circuits, McGraw-Hill, 1989.
- 4) W. Hayt & J. Kemmerly, Engineering Circuit Analysis, McGraw-Hill, 1993.
- 5) L. P. Huelsman, Basic Circuit Theory, Prentice-Hall, 1984.

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. identify the two types of resonance circuits
2. analyze resonance circuits to get the resonant frequency, corner frequencies, power, bandwidth, and quality factor
3. analyze electric circuits with magnetically-coupled elements
4. analyze the ideal op-amp circuits: inverting, non-inverting, adders, subtractors, integrators, and differentiators
5. analyze op-amp circuits to calculate the transfer function
6. differentiate whether or not a circuit has initial conditions, and find them if not given
7. transfer circuit elements into Laplace domain and solve circuits using Laplace transform method
8. calculate the Fourier Series coefficients of periodic signals
9. analyze electrical circuits of multiple periodic sources utilizing Fourier Series techniques
10. mathematically derive the Fourier Transform of non-periodic signals
11. analyze electrical circuits of non-periodic sources utilizing Fourier Transform techniques
12. derive the impulse response and the transfer function of linear systems using Fourier and Laplace Transforms
13. derive the convolution integral form of two signals
14. use the convolution integral to find the response of electrical circuits
15. use the graphical method of the convolution integral to find the electrical circuit response
16. differentiate between one-port and two-port networks

17. calculate the different parameters of two-port networks: Z-parameters, Y-parameters, H-parameters, G-parameters, transmission-parameters, and the inverse-transmission-parameters
18. analyze the terminated and non-terminated two-port networks
19. analyze two-port networks in different interconnections

**Course Topics:**

1. Operational Amplifiers (Chapter 5)
2. Magnetically Coupled Circuits (Chapter 13)
3. Frequency Response (Chapter 14)
4. The Laplace Transform (Chapter 15)
5. Applications of Laplace Transforms (Chapter 16)
6. Fourier Series (Chapter 17)
7. Fourier Transform (Chapter 18)
8. Two-Port Networks (Chapter 19)

**Class Schedule:**

Lecture: Sun & Tue. : 9:30 – 11:00  
 Tutorials: Tue. : 2:30 – 4:20

**Course Contribution to Professional Component:**

Engineering Science: 100 %  
 Engineering Design: 0 %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M				M								M	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Muhammad Ashenkeeti**

**Last Updated: October, 2007**

**EE 302 – ELECTROMAGNETIC FIELDS (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** An introduction to electromagnetic fields. Topics include: Revision of Wave Motion, Introduction to Transmission Lines, Revision of Vector Algebra and Calculus, Electrostatics, Magnetostatics, and Magnetic Induction.

**Prerequisites:** EE 250, MATH 203

**Textbook:** Ulaby, F., Fundamentals of Applied Electromagnetics, Prentice-Hall, 2004 Media Edition

**References:** None

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe waves mathematically
2. classify waves in different ways of comparison
3. express time-harmonic waves in phasor form and vice versa
4. state the application criterion of transmission line theory
5. classify transmission lines according to their propagation modes
6. produce the voltage and current expressions along the transmission line
7. define the following transmission line parameters: propagation constant, phase constant, attenuation constant, and characteristic impedance
8. compute the reflection coefficient, SWR, and input impedance of the transmission line
9. identify the basic features of the standard three curvilinear coordinate systems
10. convert a vector from one coordinate system to another
11. explain the physical meaning of the gradient, divergence, and curl operations
12. compute the gradient, divergence, curl, and Laplacian of vector fields in different coordinate systems
13. compute the electric forces for system of point charges using Coulomb's law
14. compute the electric field of charge distributions using superposition integral
15. compute the electric field of symmetric charge distributions using Gauss's law
16. produce the electric potential of charge distributions using superposition
17. produce the electric potential from the electric field of charge distribution and vice versa
18. solve Poisson's or Laplace's equation to find the potential for simple symmetric cases
19. develop expressions for and apply the boundary conditions of electric field
20. explain the phenomenon of polarization inside dielectrics and its effect on the interior electric field
21. compute the capacitance of capacitors of different configurations
22. compute the stored electrostatic energy within an electric field region
23. use the image method to find the electric field of charge distributions near planar perfect electric conducting sheets
24. compute the magnetic force on a moving charge in a static magnetic field
25. compute the magnetic field due to different current distribution using Biot-Savart law
26. explain the non-divergence property of magnetic fields using Gauss's law for magnetism
27. use Ampere's law to find the magnetic field due to symmetric direct current distribution
28. develop expression for and apply the boundary conditions for magnetic fields
29. discuss the phenomenon of Hysteresis in magnetic materials
30. compute self and mutual inductance of different inductor configurations
31. compute the magnetic energy stored in static magnetic field region
32. discuss the analogy between electrostatics and magnetostatics

33. discuss Faraday's law of induction
34. compute the induced emf in stationary loops placed in a dynamic magnetic field (transformer emf)
35. compute the induced emf in a loop moving inside a stationary magnetic field (motional emf)
36. extend Ampere's law to the dynamic case
37. describe mathematically the coupling between dynamic electric and magnetic fields (Maxwell's equations)

**Course Topics:**

1. **Introduction to Waves & Phasors:** Dimensions, Units, & Notation; Nature of EM; Traveling Waves; The EM Spectrum; Review of Complex Numbers & Phasors
2. **Transmission Lines:** Introduction; Lumped Element Model; TL Equations; Wave Propagation on TL's; Lossless TL; Input Impedance of a TL
3. **Vector Analysis:** Vector Algebra; Coordinate Systems; Vector Calculus
4. **Electrostatics:** Maxwell's Equations; Charge & Current Distributions; Coulomb's & Gauss's Laws; Electric Scalar Potential; Electric Material Properties; Conductors & Dielectrics; Electric Boundary Conditions; Laplace's and Poisson's Equations; Capacitance; Potential Energy; Image Method
5. **Magnetostatics:** Magnetic Forces & Torques; Biot-Savart Law; Force between Parallel Conductors; Ampere's Law; Magnetic Boundary Conditions; Inductance; Magnetic Energy
6. **Time Varying Fields:** Faraday's Law; Stationary Loop in Time-Varying Magnetic Field; Ideal Transformer; Moving Conductor in Static Magnetic Field; Moving Conductor in a Time-Varying Magnetic Field; Continuity Equation

**Class Schedule:**

Lecture: 3 one-hour periods per week  
 Tutorials: 1 two-hour period per week

**Course Contribution to Professional Component:**

Engineering Science: 100%  
 Engineering Design: 0%

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L				M								L				

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Muntasir Sheikh**

**Last Updated: October, 2007**

**EE 311 – ELECTRONICS I (4,3,3) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Characteristics of diodes, bipolar junction transistors and field effect transistors. States/modes of operation of these devices. Large-signal and small signal circuit models. Application of these devices in basic electronic circuits: rectifiers, limiting circuits, regulated power supplies, logic circuits, electronic switches, amplifiers.

**Prerequisites:** EE 250

**Textbooks:** Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits (5<sup>th</sup> Ed), Oxford University Press, 2003

**References:** Rashid, Mohammed H., Microelectronic Circuits, PWS Publishing Company, 1998  
Jacob Millman and Arvin Gabel, Microelectronic (2nd Ed), McGraw-Hill, 1987

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. reproduce the current-voltage characteristics of an ideal diode and a pn junction diode in a graph and as a functional relationship
2. identify and distinguish between different modes and regions of operation of a diode
3. Analyze diode circuits using graphical and iterative methods
4. prepare piecewise linear models of diodes and apply them to the analysis of diode circuits
5. sketch the load line and compute the operating point (bias point, quiescent point, Q-point) in a diode circuit
6. separate the complete analysis into DC analysis and AC analysis and produce the small signal model of diodes
7. analyze basic diode circuits (rectifiers, clippers, zener shunt regulators)
8. design a rectifier circuit and shunt regulated DC power supply
9. recall and sketch the Ebers-Moll model of a BJT
10. define and distinguish between different modes of operation of BJT
11. Analyze a BJT circuit having DC sources only
12. design a BJT biasing circuit
13. Analyze BJT amplifiers of various configurations
14. design a BJT amplifier with given gain, input and output resistance
15. define and distinguish between different modes of operation of FET
16. recall the current-voltage relation of FET
17. Analyze a FET circuit with DC sources only
18. design a FET biasing circuit
19. Analyze FET amplifiers of various configurations
20. design a FET amplifier with given gain, input and output resistance
21. conduct experiment to measure device (diode, BJT, FET) characteristics and report results



22. conduct experiments to measure characteristics of electronic circuits (rectifiers, clipping circuits, amplifiers) and report results
23. use ORCAD PSPICE in solving problems and designs
24. setup experiments to verify the performance of designed circuits
25. Collect info and report about an electronic device

**Course Topics:**

**Ideal diodes and its i-v characteristic.**

(2 weeks)

1. Terminal characteristic of junction diodes.
2. Techniques of the diode circuit analysis.
3. The small signal model of the diodes. (1 week)
4. Operation in the breakdown region the-zener diodes.
5. Application of diodes in typical circuits: rectifiers, regulated power supplies, logic gates, limiting circuits etc. (2 weeks)

**Bipolar Junction Transistors (BJT's)**

6. Physical structure, NPN and PNP transistors. (1 week)
7. Elebrs-Moll model and graphical representation of BJT characteristics.
8. Analysis of BJT circuits at DC: modes of operation, transistor as a switch, biasing the BJT. (2 weeks)
9. Transistor as an amplifier, graphical analysis, small signal equivalent circuit models. (2 weeks)
10. Analysis of basic BJT amplifier configurations.

**Field Effect Transistors (FETs)**

11. Current- Voltage characteristics of different types of FETs, regions of operation. (1 week)
12. Analysis of FET circuits at DC, biasing the FET. (2 weeks)
13. FET as an amplifier, graphical analysis, small signal equivalent circuit models. (2 weeks)
14. Analysis of basic FET amplifier configurations.

**Class Schedule:**

Lecture: two one and half hours sessions per week

Tutorials/Lab: one two-hours lab and one-hour tutorial sessions per week

**Course Contribution to Professional Component:**

Engineering Science: 65 %

Engineering Design: 35 %

**Course Relationship to Program Outcomes:**

P Outcomes	Engineering Criteria										Program Criteria						
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Av. attainable level of learning (*)	M	M	M		M	L	M		M		M		M				

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Solimanul Mahdi**

**Last Updated: October 2007**

**EE 312 – ELECTRONICS II (4,3,3) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Feedback in amplifiers. Frequency response of amplifiers. Operational amplifiers: design and applications as linear and non-linear analog building blocks, adders, subtractors, differentiators, integrators, analog simulation, active filters. Logarithmic and exponential amplifiers, precision converters, analog multipliers, wave-shapers, sinusoidal and square wave oscillators.

**Prerequisites:** EE 311

**Textbooks:** Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits (5th Ed), Oxford University Press, 2003

**References:** Rashid, Mohammed H., Microelectronic Circuits, PWS Publishing Company, 1998

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. identify the components that influence the bandwidth of single and multistage common-emitter and common-collector BJT amplifiers
2. calculate the bandwidth of a given single and multistage BJT amplifier
3. design a single and multistage CE-CC BJT amplifier with specified bandwidth
4. identify the topology of amplifiers with feedback
5. convert feedback amplifiers into equivalent amplifiers without feedback
6. calculate the gain, input and output resistances of BJT feedback amplifiers
7. describe the external characteristics of op-amps
8. analyze the operation of linear analog circuits using ideal op-amps
9. design linear analog building blocks using op-amps, e.g., general adder/subtractors, differentiators, integrators, precision rectifiers, instrumentation blocks, analog computers, digital-to-analog and analog-to-digital converters
10. classify the type of a given filter
11. determine the type and the order of the filter needed to meet the specifications
12. calculate the poles of the required transfer function
13. design analog active filters with given specifications
14. estimate the implementation cost of BJT amplifiers, op-amp application and active filters
15. simulate and verify amplifiers and filters using CAD tools
16. prepare a PCB for a given analog design using CAD tools
17. work in a team effectively

Course Topics:

1. Review of basic BJT Amplifiers
2. Frequency response
3. Feedback Amplifiers
4. Operational Amplifiers
5. Filters and Tuned Amplifiers

- 6. Signal Generators
- 7. Project

**Class Schedule:**

Lecture: two one and half hours' sessions per week  
 Tutorials/Lab: one two hours lab and one-hour tutorial sessions per week

**Course Contribution to Professional Component:**

Engineering Science: 65 %  
 Engineering Design: 35 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
P Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Av. attainable level of learning (*)	M	M	H	M	H						M						

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Ashraf Uddin**

**Last Updated: October 2007**

**EE 321 – INTRODUCTION TO COMMUNICATIONS (4,3,3) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Fourier Signal Analysis. Linear Modulation: AM, DSBSC, SSB, Frequency Conversion, generation and detection, FDM, Exponential Modulation: FM, PM, NBFM, WBFM. Pulse Modulation, Sampling Theorem, PAM, PDM, PPM, TDM, PCM.

**Prerequisites:** EE 301

**Textbooks:** B. P. Lathi, “Modern Digital and Analog Communication Systems”, Oxford University Press, 3<sup>rd</sup> edition, 1998.

**References:** 1. S. Haykin, “Communication Systems”, 4<sup>th</sup> edition, Wiley.

2. A. Bruce Carlson, Paul B. Crilly, Janet C. Rutledge, “Communication Systems: An Introduction to Signals and Noise in Electrical Communications”, 4<sup>th</sup> edition, McGraw-Hill, 2002

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. classify a signal as an energy or power signal
2. classify a system as linear or non-linear, time-varying or time-invariant, causal or non-causal
3. define impulse response and transfer function of a system
4. evaluate impulse response and transfer function of a LTI system
5. compute the output of a system for a given input
6. classify a filter as low-pass, band-pass, band-reject, or high-pass
7. apply Fourier series and transform to analyze LTI systems with periodic and non-periodic inputs
8. apply convolution to evaluate the output of a LTI system
9. define and find the bandwidth of a LTI system
10. define modulation
11. explain the need for, and list basic applications of, modulation
12. define and write mathematical expressions for different types of AM modulation
13. analyze AM modulated signals in time and frequency domains
14. compute the power and bandwidth of an AM modulated signal
15. analyze of operation of AM modulators and demodulators
16. define and write mathematical expressions for angle modulation
17. analyze angle-modulated signals in time and frequency domains
18. compute the power and bandwidth of an angle-modulated signal
19. analyze of operation of angle modulators and demodulators
20. analyze or design a frequency division multiplexer
21. analyze or design a superheterodyne receiver

22. explain the sampling theorem and its applications in A/D conversion and time division multiplexing
23. explain the principles of PAM, PWM, PPM, PCM
24. analyze a PAM/TDM system

**Course Topics:**

1. Classifications of signals and systems. Energy and power signals, Linear time invariant systems (LTI), Fourier series representation, Fourier transform, Spectral properties and bandwidth, unit step and unit impulse functions, Impulse response and transfer function of linear systems, Filters (LPF, HPF, and BPF)
2. Amplitude modulation (Double side-band - Large carrier (DSB-LC)), Double side-band - Suppressed Carrier (DSB-SC), Single side-band (SSB); Hilbert Transform , Vestigial side-band (VSB); Spectral analysis, modulators, demodulators, Super heterodyne receiver.
3. Frequency modulation, Phase modulation; spectral analysis, bandwidth, generation, detection, discriminators, phase-locked-loop (PLL), Frequency division multiplexing (FDM)
4. Sampling theorem, Pulse amplitude modulation (PAM), Time-division multiplexing (TDM), Pulse width modulation (PWM), Pulse position modulation (PPM), Pulse code modulation (PCM)

**Class Schedule:**

Lecture: 3 one-hour periods per week

Tutorials/Lab: one two hours lab and one-hour tutorial sessions per week

**Course Contribution to Professional Component:**

Engineering Science: 85 %

Engineering Design: 15 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M		M		M								L	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Abdullah Dobaie**

**Last Updated: October 2007**

**EE 331 – PRINCIPLES OF AUTOMATIC CONTROL (4,3,2) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Introduction to control systems with examples from different fields. Transfer functions and block diagram algebra. Stability analysis (Routh-Hurwitz and Nyquist). Design of Control Systems using Bode diagrams and root locus techniques

**Prerequisites:** MATH 204, EE 300, and EE 301

**Textbooks:** B.C. Kuo, Automatic Control Systems, 7th ed., Prentice-Hall, 1995.

**References:** K. Ogata, Modern Control Engineering, 3rd ed, Prentice Hall, 1991

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe some practical examples and draw the corresponding block diagram
2. explain the difference between the open and closed loop control system
3. apply the MATLAB in solving mathematical problems
4. develop mathematical models (differential equations, state - variables, transfer functions) for a variety of dynamic physical systems
5. apply the theory of Signal Flow Graph in finding the transfer function of the systems
6. analyze the control system using the state - variables approach
7. analyze the control system in the time domain ( steady state error and transient response)
8. analyze the stability of linear control system using ( direct method, Routh - Hurwitz Test, and the Root Locus plot)
9. designing feedback control systems
10. gain experience in technical writing, and improve communication skills

**Course Topics:**

1. Introduction (1 week)
2. Mathematical Background (2 weeks)
3. Transfer Function, Block Diagram, and Signal Flow Diagram (2 weeks)
4. Modeling of Physical Systems (2 week)
5. State Variable (2 weeks)
6. Time Domain Analysis (1 week)
7. Stability of Linear Control Systems (1 week)
8. Root Locus Techniques (2 weeks)
9. Designing of feedback systems (2 weeks)

**Class Schedule:**

Lecture: two of one-and-a-half hour lectures per week  
Tutorials: a two-hours lab/tutorial per week

**Course Contribution to Professional Component:**

Engineering Science: 90 %

Engineering Design: 10 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L		M		M		M				M		M	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Prof. Dr. Ali Hasan Bamani****Last Updated: October, 2007**

**EE 332 – COMPUTATIONAL METHODS IN ENGINEERING (3,3,1) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Introduction, The IMSL library, Solution of non-linear equations- solution of large systems of linear equations, Interpolation, Function approximation, Numerical differentiation and integration, Solution of the Initial value problem of ordinary differential equations. Circuit applications

**Prerequisites:** EE 201, MATH 204

**Textbooks:** Burden RL and Faires JD, Numerical Analysis, 7<sup>th</sup> ed, Brooks/Cole Pub Co. 2000

**References:** Rice JR, Numerical Methods, Software, and Analysis, 2<sup>nd</sup> ed McGraw-Hill, 1992

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe concepts and techniques for numerical analysis, methods and algorithms
2. define solutions of equations in one variable
3. define solutions of equations in multi variables
4. apply the curve fitting method for experimental data
5. define the numerical differentiation and integration
6. apply the initial value problem
7. solve simple problems given at the end of each topic using hand and scientific calculator
8. apply the various learned algorithms and methods using structured programming

**Course Topics:**

1. Mathematical backgrounds
2. Solution of equations in one variable. It is also called root-finding problem: the Bisection algorithm, fixed point Iteration, the Newton Raphson Method, the Secant Method, the Graphical Method.
3. Direct Methods Of Solving Linear Systems: Linear System of Equations, Gaussian Eliminations and Backward Substitution and Gauss-Jordan Methods, Linear Algebra and Matrix Inversion, the Determinant of a Matrix, Iterative Techniques for Solving Linear Systems. (Gauss-Siedel Algorithm).
4. Numerical Solutions Of Non-Linear Systems Of Equations: Fixed Points for Functions of Several Variables, Newton's Method.
5. Curve Fitting: Lagrange Method, Divided-Difference Method, Discrete Least Squares Approximation.
6. Numerical Differentiation and Integration: Numerical Differentiation, Numerical Integration, Composite Numerical Integration.
7. Initial Value Problems (Single And Multi-Variables) (Out Of Text): Euler Method, 2nd-order Runge-Kutta Method, 4th-order Runge-Kutta Method.



8. Overall review and applications

**Class Schedule:**

Lecture: two one and half hours sessions per week  
 Tutorials: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L	M	H	H	M	M	H	M	M		M		M	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. M. Alfheid**

**Last Updated: October 2007**

**EE 341 – ELECTROMECHANICAL ENERGY CONVERSION I (4,3,2) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** This course includes, magnetic circuits, principle operation of single-phase transformer and experimental tests, multi windings transformer and auto-transformer, potential and current transformer, basic principle of rotating machine, steady state operation of different types of DC-machine DC machine, steady state torque speed characteristic.

**Prerequisites:** EE302

**Textbooks:** Fitzgerald, Kingsley and Umans, "Electric machinery", 6th edition, McGraw-Hill, 2006

**References:**

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe the magnetic circuit parameters
2. summarize the mathematical relationships between the different variables of the magnetic circuits
3. differentiate between the different types of losses in the magnetic circuits
4. calculate the variables of the magnetic circuit
5. recognize the polarity of the coil turn and perform the dc resistance test for single-phase transformers
6. derive the transformer equivalent circuit
7. analyze the approximate equivalent circuit of the transformer from the engineering aspects
8. carry out the open-circuit and short-circuit tests of the single-phase transformers
9. calculate values of the transformer equivalent circuit from the above tests
10. construct the phasor diagram of the single-phase transformer under different operating conditions
11. derive the mathematical expressions of the voltage regulation
12. investigate the effect of changing the power factor on the voltage regulation of the transformer
13. investigate the construction and precaution which should be considered for potential and current transformers
14. calculate the efficiency of the single phase transformer
15. recognize the electromechanical energy conversion principles
16. derive the induced emf for the ac machines
17. identify the rotating machine concepts
18. classify the different types of the direct current (DC) machines
19. identify the effect of the armature reaction of the mmf
20. justify the main function of the series field winding in DC machine
21. assess the different problems raised due to armature reactions in the DC machines

22. develop a solution to overcome the shifting of neutral zone of DC machines
23. perform the open-circuit test on a DC machine
24. differentiate different schematic diagrams of the DC machines
25. evaluate the functions of the interpole in DC machines
26. recognize the effect of the compensating field winding to improve the mmf distributions in DC machines
27. asses the need for additional windings in DC machine for improving the mmf distributions
28. compute and predict the torque versus speed characteristics of a DC machine

**Course Topics:**

Course Topics	Duration in weeks
1- magnetic circuits transformers	2
2- principle operation of single phase transformer, equivalent circuit, efficiency, voltage regulation, phasor diagram and experimental tests.	3
3- multi windings transformer, auto-transformer, voltage and current transformer	2
4- basic concept of rotating machine and the mmf distribution	2
5- steady state analysis for DC machine	2
6- Dc machines Dynamic and control	3

**Class Schedule:**

Lecture: two 1.5 hour sessions per week  
 Tutorials/Lab: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 100 %  
 Engineering Design: %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	M			M	M		M			M		H				

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Abdulaziz Jalal Al-Sharief**

**Last Updated: October, 2007**

**EE 360 – DIGITAL DESIGN I (4,3,2) 4 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Digital Design I is a study of the basic principle of logic design. It enables the student to apply switching theory to the solution of the logic design problems, network design using a variety of algebraic and graphical techniques such as Boolean Algebra and Karnaugh Maps among others. A wide variety of multiple-output networks such a MUX, Decoder, ROM, and PLA are made handy to the student for designing complex combination networks. Special emphasis on the study of flip-flops memory devices enables the student to design several sequential network such as counters, code converters, shift registers and similar networks.

**Prerequisites:** EE 311

**Textbooks:** Charles H. Roth Jr., Fundamentals of Logic Design, 4th Ed. Thomson Brooks, 2004. ISBN: 0534 37804 4

**References:** M. Mano, Digital Design, Prentice Hall Inc., 2002

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. describe and convert the different number systems and codes
2. apply various techniques to simplify Boolean functions
3. design multi-level and multiple output gate networks
4. use multiplexers and decoders to design basic combinational circuits
5. design a ROM to realize given Boolean functions
6. design a PLA to realize given Boolean functions
7. design combinational Networks
8. compare between the functions of different Flip-Flops, their merits and applications
9. use Flip-Flops to design digital Counters
10. design shift registers and similar sequential networks
11. design and implement sequential networks such as counters, code converters, shift registers and similar networks
12. use software tools to design, simulate, test, and document digital systems

**Course Topics:**

1. Number systems and codes
2. Boolean Algebra, Logic Gates, Karnaugh Maps
3. Mutli-level gate network, Multiple output networks
4. Multiplexers, Decoders
5. Read-only memories (ROM), Programmable Logic Arrays (PLA)
6. Design of Combinational Networks
7. Flip-Flops, Design of Digital Counters
8. Design of Shift Registers and similar Sequential Networks

**Class Schedule:**

Lecture: two 1.5 hour sessions per week  
 Tutorials: One two lab/tutorial hours per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	H	H		H	L	H		L		H		H	M			

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Adnan Kaki**

**Last Updated: October 2007**

**EE 370 – BIOMEDICAL ENGINEERING PRIMER (3,2,3) 3 Credits**  
(Core course offered in Fall term)

**Bulletin Description:** Biomedical engineering fields of activity. Research, development, and design for biomedical problems, diagnosis of disease, and therapeutic applications. Modular blocks and system integration. Physical, chemical and biological principles for biomedical measurements. Sensors for displacement, force, pressure, flow, temperature, biopotentials, chemical composition of body fluids and biomaterial characterization. Patient safety.

**Prerequisites:** PYHS 202 E, IE 201, BIO 321 E (concurrent)

**Textbooks:** Enderle J.D. (Editor), Blanchard S.M. Introduction to Biomedical Engineering, Academic Press; 2000 ISBN: 0122386604.

**References:** Webster, J. G. (ed), Medical Instrumentation: Application and Design, John Wiley and Sons, 3rd ed.1997

Carr, J.J. and Brown J.M., Introduction to Biomedical Equipment Technology, Prentice Hall, 3rd ed.1998.

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. identify most of the different disciplines of biomedical engineering
2. recognize the different fields of activities in which biomedical engineers may work
3. understand the different problem types and problem-solving approaches in biology, and medicine
4. list some of the simple and standard diagnostic techniques and relate them to engineering principles
5. describe the types of research studies and biostatistical parameters used in investigating medical instruments and therapeutics
6. name a few major therapeutic techniques and recognize their principle of operation
7. outline techniques to record, analyze, and display biological and medical signals
8. identify and sketch the main blocks of a medical device
9. relate professional ethics and moral in clinical engineering fields
10. discuss ways biomedical engineers can contribute to solve societal problems
11. understand the potential hazards in the laboratory and clinical environments
12. describe the origin and characteristics of biopotentials within living organisms
13. explain the operating principles, advantages, and disadvantages of thermocouples, thermistors, and RTDs
14. determine the critical issues for sensor choice, placement, and circuit implementation through laboratory investigation of a particular temperature-sensing application
15. explain the operating principles, advantages, and disadvantages of inductive proximity sensors
16. explain the operating principles, advantages, and disadvantages of capacitive proximity sensors
17. understand and analyze sensor and electrode designs for recording biosignals
18. appreciate the applications and limitations of instrumentation in clinical environments

**Course Topics:**

- |  |          |
|--|----------|
| 1. Biomedical Engineering Fields of Activities           | (1 Week) |
| 2. Research, development, and design biomedical problems | (1 Week) |
| 3. Diagnosis of diseases                                 | (1 Week) |
| 4. Therapeutic applications                              | (1 Week) |
| 5. Modular blocks and system integration                 | (1 Week) |

- 6. Biomedical measurement principles (2 Week)
  - a. Physical principles
  - b. Chemical principles
  - c. Biological principles
- 7. Biomedical sensors (2 Week)
  - a. Sensors for displacement
  - b. Force sensors
  - c. Pressure sensors
  - d. Flow sensors
  - e. Temperature sensors
  - f. Biopotential sensors
- 8. Body fluids chemical composition measurement (1 Week)
- 9. Biomaterial characterization (1 Week)
- 10. Patient safety (1 Week)
- 11. Diagnostic Imaging equipment (2 Week)
  - a. Ultrasound
  - b. X-Ray
  - c. Fluoroscopy
  - d. Angiography & Cath-lab
  - e. CT
  - f. MRI

**Class Schedule:**

Lecture: two one and half hours sessions per week  
 Tutorials/Lab: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

P Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L	L	M		L	L	L	L		L	L	L	L		M	L	L

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Yusuf A Al-Zuhairy**

**Last Updated: October 2007**

**EE 390 – SUMMER TRAINING (10 weeks) (2,0,0) 2 Credits**  
(Core course offered in every summer)

**Bulletin Description:** Training in industry under the supervision of a faculty member. Students have to submit a report about their achievements during training in addition to any other requirements as assigned by the department.

**Prerequisites:** EE 321, EE 331, IE 331

**Textbooks:** None.

**References:** None.

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. Formulate an objective or mission statement that identify the real problem and describe the expected outcomes of the training activity.
2. Break-down a work environment into its units and work functions, and describe how these units are assembled into a whole entity.
3. Describe a professional organizational structure, its size and how it is related to its main products and to market issues.
4. Exhibit integrity, punctuality, and ethical behavior in engineering practice and relationships.
5. Demonstrate enthusiasm and business focusing.
6. Establish successful relationships with team members, advisors, and clients to understand their needs and to achieve or exceed agreed-upon quality standards.
7. Maintain focus to complete important tasks on time and with high quality, amidst multiple demands
8. Relate practical work to previous knowledge from basic sciences, engineering fundamentals, and discipline related courses.
9. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources
10. Utilize prior knowledge, independent research, published information, and original ideas in addressing problems and generating solutions
11. Monitor achievement, identify causes of problems, and revise processes to enhance satisfaction
12. Communicate, clearly and concisely, training details and gained experience, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.

<b>Course Topics:</b>	<b>Duration in weeks</b>
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1. Acquainting the trainee by the company, its work environment, organizational structure, products, costumers, engineering units, and quality system.	2
2. Familiarizing the trainee of one production or design unit with deep understanding of the work environment, regulations, standards, etc...	1
3. Allocating the trainee to a project team and allowing him to study and collect necessary data about the project using internal and external data sources.	1
4. Working as a team member to execute assigned tasks with the following objectives: 1. Apply engineering practices related to his specialization. 2. Enhance team work skills. 3. Relate practical work to his engineering knowledge. 4. Use modern engineering tools such as equipment and computer software. 5. Use project management techniques. 6. Complete assigned tasks on time with high quality. 7. Develop personal communication skills.	6

**Class Schedule:**

Lecture:

Tutorials/Lab: Oral Presentation after submitting a written training report; both evaluated by at least 2 faculty members

**Course Contribution to Professional Component:**

Engineering Science:

Engineering Design: 100 %

**Course Relationship to Program Outcomes:**

P Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)			M	M	M	H	H	M	M	M	H						

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Bahattin Karagözoğlu**

**Last Updated: June 2008**

**EE 465 – MICROCOMPUTERS FOR ELECTRICAL ENGINEERS (4,3,3) 4 Credits**  
(Core course offered in Fall term)

**Bulletin Description:** The concept of microcomputer and micro computing, advantages of microprocessors, its impact, utility, and application areas. Simplified architecture, microprogramming and technology of microcomputers. How microcomputers work. I/O structures and techniques, networks and interfacing. Microcomputer as a controller. Information storage devices. Use of digital building blocks MSI circuits in various application examples.

Open to non-computer option students only.

**Prerequisites:** EE 360

**Textbooks:** No definite textbook is followed.

**References:** E.E. Klingman, Microprocessor System Design, Prentice-Hall, 1987;

D.R. McGlynn, Modern Microprocessor System Design, John Wiley & Sons, 1980;

R. White, How Computers Work, Ziff-Davis Press, 1995.

M.M. Morris, Digital Design, Prentice-Hall, 1984

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. Express the number system, Boolean algebra and gate network
2. Recognize digital computer block diagram, basic components and fundamentals
3. Choose a digital computer system for scientific applications, business application and control systems including its peripherals (monitors, printers, scanners, data loggers, digitizers, etc... )
4. Describe how computers work and install PCs
5. Recognize a microprocessor system design and architecture
6. Express the operation of the arithmetic-logic unit
7. Assemble computer peripherals using Medium Scale Integrated Circuits (MSI), MUX, comparators, decoders, latches
8. Choose I/O devices, Computer interfacing and PC add-on boards for specific biomedical applications
9. Distinguish information storage devices, control units, buses and interfaces
10. Install and upgrade operating (DOS, MS Windows, Mac system) and application (MS office programs, Paint, Draw) software
11. Design techniques to record, analyze, and display biological and medical signals.
12. Document his work in a written report and defend it orally

**Course Topics:**

1. Review of number system, Boolean algebra and gate network (1week)

2. Digital computer block diagram, basic components and fundamentals (1/2 week)
1. Digital computer, sizes, uses, scientific applications, business application and control systems (2 weeks)
2. How computers work (2 weeks)
3. Microprocessor system design and architecture (2 weeks)
4. The arithmetic-logic unit (1 week)
5. Medium Scale Integrated Circuits (MSI), MUX, comparators, decoders, latches (3 weeks)
6. Information storage devices (1 week)
7. The control unit, buses and interfaces(1 week)
8. I/O devices (2 weeks)

**Class Schedule:**

Lecture: two one and half hours sessions per week  
 Tutorials/Lab: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L		M		M		M	M	M		L		M				H

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Yusuf A Al-Zuhairy**

**Last Updated: October, 2007**

**EE 470 – BIOMEDICAL SIGNALS AND SYSTEMS (4,3,3) 4 Credits**  
(Core course offered in Spring term)

**Bulletin Description:** Models for biomedical systems. Non-deterministic nature of biomedical signals, physiological systems and quantitative analysis. Statistical analysis of experimental data. Frequency response of systems and circuits. A/D conversion, sampling, and discrete-time signal processing. Biomedical amplifiers, filters, signal processors and display devices. Power supplies for medical equipment. Laboratory and computational experiences with biomedical applications. Term project.

**Prerequisites:** EE 253, EE 301, EE 370 and IE 202

**Textbooks:** M.J. Roberts, **Signals and Systems, Analysis Using Transform Methods and MATLAB**, McGraw-Hill, 2004.

**References:** A.V. Oppenheim, A.S. Willsky, I.T. Young :Signals and Systems, Prentice - Hall, 2<sup>nd</sup> ed 1996;  
E.N. Bruce: Biomedical Signal Processing and Signal Modeling, Wiley 2001;  
D.K. Lindner: Introduction to Signals and Systems, McGraw-Hill, 1999.

### Course Learning Objectives (CLO)

After finishing the course successfully, the BME student shall

1. **Express** signals in terms of basic signal components in time domain
2. **Recognize** transformations of continuous-time (CT) and discrete-time (DT) functions
3. **Identify** real and complex exponential CT and DT functions
4. **Sketch** signals and system responses (using MATLAB<sup>®</sup>)
5. **Recognize** periodicity and **identify** harmonics of CT and DT functions
6. **Identify** and **use** impulse and signals derived from it
7. **Generate** a signal from its harmonics (using MATLAB<sup>®</sup>)
8. **Describe** systems using differential/difference equations
9. **Compute** the impulse response of the system given the differential/difference equation
10. **Compute** the output of a system for a given input and its impulse response
11. **Describe** systems using block diagrams and transfer functions
12. **Infer** transfer functions from block diagrams and differential/difference equations and vice versa
13. **Produce** the frequency response function from the transfer function
14. **Infer** output from the transfer function and input
15. **Predict** bounded input bounded output stability of a linear time-invariant system
16. **Compute** continuous and discrete-time Fourier transforms
17. **Sketch** Fourier transform and frequency response plots using MATLAB<sup>®</sup>
18. **Develop** the frequency response function from the Bode plots
19. **Compute** system parameters from step and sinusoidal frequency response plots
20. **Solve** mathematical problems using MATLAB<sup>®</sup>
21. **Formulate** system characteristics in MATLAB<sup>®</sup>
22. **Design** a biomedical signal processor to extract a feature from the raw biomedical signal
23. **Use** experiments to find transient, steady state and frequency responses of first and second order systems
24. **Identify** transfer function model for a given system and **asses** the time and frequency behavior of the system

25. **Assess** affects of sampling rate in generating the discrete-time signals and estimate the proper sampling frequency
26. **Predict** the number samples needed to study a continuous-time signal and **choose** a proper window function
27. **Analyze** problems in a team work setting and **evaluate** the performance of team members
28. **Illustrate** results and solutions in a written report
29. Orally present and **defend** his solutions
30. **Demonstrate** independent problem solving and life-long learning skills
31. Statistically **analyze** data

**Course Topics:** A tentative timetable will be prepared with details of topics after the pre-test

1. Introduction to signals and systems, concept of a system model, system and signal basics (2 weeks)
2. System description; linear time-invariant systems, properties and representation by linear differential and difference equations, impulse response, convolution and frequency response functions (2.5 weeks)
3. Signal and system analysis using Fourier series and transforms (2 weeks)
4. A/D conversion, sampling, and discrete-time signal processing. (1 weeks)
5. Biomedical amplifiers, filters, signal processors and display devices (1.5 weeks)
6. Experimental methods for system identification, statistical analysis of experimental data. Frequency response of systems and circuits (2 weeks)
7. Noise removal and signal compensation (2 weeks)
8. Term project (1 week)

**Class Schedule:**

Lecture: three 1 hour sessions per week  
 Tutorials/Lab: one 3.0 hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	M	H	M	M		M		M		M	M	M	M		M	

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. B. Karagözoğlu**

**Last Updated: December, 2006**

**EE 471 – BIOMEDICAL INSTRUMENTATION (3,2,3) 3 Credits**  
(Core course offered in Fall and Spring terms)

**Bulletin Description:** Electrical safety and precautions required in medical applications. Electrocardiography (ECG), analog and digital processing of ECG signals. Measurement of blood pressure, heart sound, flow and volume of blood. Statistical analysis of heart rate and blood pressure measurements. Basic respiratory system measurements. Principles of clinical lab instrumentation. Term project.

**Prerequisites:** EE 312, PHY 372, EE 470 (Concurrent)

**Textbooks:** Webster, J.G. (ed) Medical Instrumentation: Application and Design 3rd ed. John Wiley & Sons, 1997;

**References:** Carr, J.J. and Brown, J.M. Introduction to Biomedical Equipment Technology, 3rd ed. Prentice-Hall, 1997.

### Course Learning Objectives (CLO)

After finishing the course successfully, the student shall

1. describe the requirements and limitations of bio-instrumentation in the clinical environment
2. devise a noise-filtering instrumentation amplifier for amplifying low-level differential signals with high common mode voltages
3. state the cause and cure of electrode–skin motion artifacts
4. sketch the equivalent circuit for glass and metal microelectrodes, and design a negative-input-capacitance amplifier
5. recognize possible noise sources and practice shielding in reducing electromagnetically coupled and inductively coupled interference
6. given currents flowing into the body and the leads of an electrocardiograph, calculate the power-line interference
7. explain the benefits and detriments of filtering and integration to reject noise
8. sketch and explain the relation between cardiac cell potentials and the electrocardiogram, and the cause of each cardiac rhythm disturbance and ST segment elevation
9. given two frontal plane leads, calculate others and the magnitude and angle of the M vector
10. describe techniques used to process, characterize, and analyze biosignals including ECG, EMG, and evoked potential
11. given specifications, design an ECG amplifier
12. sketch block diagrams of an electrocardiograph, a cardiometer, an EMG integrators and a fetal ECG detectors, and describe the function and reasons of each block
13. design the circuit for detecting electrode Fall-off
14. discuss advantages and applications of the biotelemetry system
15. recognize and interpret engineering methods used to measure blood pressure and sound
16. given the transient response of a pressure-sensor–catheter system, calculate the undamped natural frequency and damping ratio
17. describe the cause for the first and second heart sounds
18. sketch the block diagram of an automatic indirect blood pressure measurement system
19. recognize and interpret engineering methods used to measure blood flow
20. sketch and describe all instruments and equations of several techniques for blood flow measurement
21. sketch and describe several respiratory volume flowmeters
22. sketch and describe how to measure slow lung volume changes using a spirometer.
23. recognize and interpret engineering methods used to measure chemical parameters from living systems
24. sketch a pH, a PCO<sub>2</sub>, and a PO<sub>2</sub> measuring system and explain its operation
25. discuss electrical stimulation of excitable cells and explain how it is used in designing several prosthetic devices
26. sketch and explain the block diagram of some prosthetic and therapeutic devices

27. sketch a spectrophotometer and explain the need for a reagent
28. give the equation for Beer's Law and define all terms
29. explain calibration and operation of flame emission and flame absorption photometers and a fluorimeter and their advantages and disadvantages
30. explain the operation the Coulter blood cell counters and design a circuit for converting resistance to voltage
31. recognize the principles of electrical safety and the potential hazards in the laboratory and clinical environments
32. explain why electric power distribution systems are grounded and design a grounding system for an intensive care unit
33. analyze testing circuits for electrical appliances
34. design techniques to record, analyze, and display biological and medical signals
35. function and interact cooperatively and efficiently as a team member in completing laboratory projects
36. explain results and solutions in a written report
37. orally present and defend his solutions
38. demonstrate independent problem solving and life-long learning skills
39. recognize variability of the biological signals and statistically analyze data

**Course Topics:**

1. Biopotential amplifiers
2. Blood pressure and sound
3. Measurement of blood flow and volume
4. Measurements of the respiratory system
5. Electrical safety
6. Introduction to therapeutic devices
7. Clinical laboratory instrumentation
8. Chemical biosensors
9. Term projects and their presentations

**Class Schedule:**

Lecture: two one and half hours sessions per week  
 Tutorials: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 65 %  
 Engineering Design: 35 %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	M	M	M	M	M	M	H	L	M		M	L	M		M	M	M

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Haitham Al-Angari, PhD**

**Last Updated: December, 2006**

**EE 472 – BIOMEDICAL IMAGING SYSTEMS (3,3,1) 3 Credits**  
(Core course offered in Spring or both in Fall and Spring terms if demanded)

**Bulletin Description:** Fundamentals of medical imaging physics and systems: X-ray radiography, ultrasound, radionuclide imaging, and magnetic resonance imaging (MRI). Biological effects of each modality. Tomographical reconstruction principles, including X-ray computed tomography (CT), position emission tomography (PET), and single-photon emission computed tomography (SPECT)

**Prerequisites:** EE 470

**Textbooks:** K.K. Shung, M.B. Smith and B.M. Tsui, Principles of Medical Imaging, Academic Press Inc. 1992

**References:** Krupinski E.A. (ed), Medical Imaging 2000 : Image Perception and Performance (Progress in Biomedical Optics and Imaging, Society of Photo-optical Instrumentation Engineers, 2000

### Course Learning Objectives (CLO)

After finishing the course successfully, the student shall

1. define the concepts of resolution, point-spread-function, line-spread-function, modulation transfer function, signal-to-noise level, and contrast-to-noise level as they apply to images
2. describe the basic principles behind x-ray-based imaging, the fundamentals of x-ray production, and the role of all elements of an x-ray vacuum tube
3. differentiate between characteristic and general radiation, and describe their effects on image quality. The use of collimators to reduce the effect of secondary radiation, and the trade-off between signal-to-noise and contrast
4. discuss the physics of the three attenuation mechanisms: Rayleigh scattering, the photoelectric effect, and the Compton effect, as well as the different dependencies on tissue type and x-ray energy
5. apply the concept of back projection and iterative schemes for data reconstruction, and the progression of first, second, third, fourth and fifth generation computed tomography scanners
6. point out the specific clinical applications of x-ray imaging and computed tomography
7. Recognize dangers of ionizing radiation and necessity of shielding
8. compare shielding properties of different materials related to their thickness, and radiation intensity and dose
9. explain basic principles of nuclear medicine, single photon emission computed tomography, and positron emission tomography, including the origin and detection of natural radioactivity, and the relevance of half-lives
10. identify the attenuation of gamma rays in tissue, the principles behind the design of the gamma camera, and the necessity for using collimators
11. express the scintillation crystal as a detection device, the factors affecting the choice of radionuclide for clinical scanning, the technetium generator, and the chemical properties of technetium
12. recall the production methods of other radionuclides, the biodistribution of radiopharmaceuticals, and clinical scanning techniques
13. identify the specific clinical applications of nuclear medicine
14. explain the effect of putting protons inside a magnetic field, the principles discrete energy levels, and the Boltzmann equation relating the populations of quantum energy levels; reproduce the derivation of the classical equations of nuclear precession and the Larmor equation relating the rate of precession to the strength of the applied magnetic field
15. express the interactions of the magnetic field produced by a radiofrequency probe and the nuclear spins, the induced precession and the process to give rise to the NMR signal. describe the concept of chemical shift, and why protons in fat and water resonate at slightly different signals, and how this phenomenon of spin-lattice and spin-spin relaxation produces an effect on the measured NMR signal
16. recognize the techniques for measuring spin-lattice and spin-spin relaxation times, the principles behind frequency encoding, phase encoding, and slice selection in magnetic resonance imaging, and the full implementation of both spin-echo and gradient-echo imaging sequences



17. explain the theory and practical construction of radiofrequency coils, magnetic field gradients, and superconducting magnets
18. identify the specific clinical applications of MRI
19. express the basic principles of ultrasound, including longitudinal waves, the characteristic acoustic impedance (Z), the intensity reflection coefficient (R), and the basic principles of attenuation of the ultrasound wave - scattering, refraction and absorption
20. describe the instrumentation used in clinical ultrasound scanning including the transducer, improving transducer efficiency, time-gain compensation, and positioning as well as the geometry of the ultrasound beam and its dependence on the properties of the transducer; explain the characteristics of lateral and axial resolution and what factors affect them
21. recall the concepts of linear and phased arrays and the A-mode, M-mode, and real-time and static B-mode ultrasound imaging
22. apply the concept of Doppler shift to measure blood flow velocity and duplex instrumentation
23. point out the specific clinical applications of ultrasound imaging
24. describe principles and applications of fluoroscopy, catherization and angiography.

**Course Topics:**

1. Fundamentals of medical imaging physics and systems
2. X-ray radiography,
3. Ultrasound,
4. Radionuclide imaging
5. Magnetic resonance imaging (MRI)
6. Biological effects of each imaging modality
7. Tomographical reconstruction principles, including
  - a. X-ray computed tomography (CT),
  - b. position emission tomography (PET), and
  - c. single-photon emission computed tomography (SPECT)
8. Principles of fluoroscopy, catherization and angiography.

**Class Schedule:**

Lecture: two one and half hours sessions per week  
 Tutorials: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %  
 Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)	L	L	L		L	L				L	L	L	L	L		L	M

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Yusuf A Al-Zuhairy , Last Updated: December, 2006**

**EE 474 SAFETY, RELIABILITY AND MAINTENANCE IN HEALTH CARE  
FACILITIES (3,3,1) 3 Credits**  
(Elective course offered mainly in Fall terms)

**Syllabus:** Definition of safety. Electrical, gas, and fire safety and how to make safe environment for patients, medical personnel and attendants. Reliability in health care facilities. Training of operators for proper use of equipment. Generation of a computer database for equipment, suppliers, dealers and manufacturers. Preventive maintenance procedures. Corrective maintenance, repair and amendment of existing equipment. Basic troubleshooting principles. Retrieving information from manufacturer's catalogs and technical libraries.

**Prerequisites:** EE 370, IE 331

**Textbooks:** Yadin D (Editor), J.D. and Neuman M.R. *Clinical Engineering (Principles and Applications in Engineering)*, CRC Press; 2003.

**Course Learning Objectives (CLO)**

A student completing this course should at a minimum be able to:

1. Recognize national and international standards for maintaining medical equipment
2. Interpret and use service documents for the medical equipment
3. Design a clinical engineering department
4. Design maintenance procedures for medical equipment
5. Prepare policies, procedures and maintenance documents
6. Estimate failure rates of medical equipment and plan maintenance services accordingly
7. Formulate an optimum the spare and repair parts storage to minimize the downtime of equipment
8. Design processes to verify safety in medical environment
9. Coordinate and work as a member of a maintenance team

**Course Topics:** (about 1½ weeks for each topic)

1. Definition of safety
2. Electrical, gas, and fire safety and how to make safe environment for patients, medical personnel and attendants.
3. Reliability in health care facilities.
4. Training of operators for proper use of equipment.
5. Generation of a computer database for equipment, suppliers, dealers and manufacturers. Preventive maintenance procedures.
6. Corrective maintenance, repair and amendment of existing equipment.
7. Basic troubleshooting principles.
8. Retrieving information from manufacturer's catalogs and technical libraries.

**Class Schedule:**

Lecture: two one and half hours sessions per week  
Tutorials: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 75 %

Engineering Design: 25 %

**Course Relationship to Program Outcomes:**

	Engineering Criteria											Program Criteria					
Program Outcomes	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)		H		H	H	H	M	H		H	H	H					

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Abdelhameed Al-Khateeb****Last Updated: October, 2007**

**EE 476 BIOMEDICAL SYSTEMS MANAGEMENT (3,3,1) 3 Credits**  
(Elective course offered mainly in Spring terms)

**Syllabus:** Responsibilities of biomedical engineers working in health-care facilities. Codes, standards and regulations governing clinical engineering practices. Bids preparation and tender evaluation. Designing and layout of medical facilities. Equipment selection and evaluation. Term project.

**Prerequisites:** EE 370

**Textbook:** Bronzino J.D. (Editor), *Management of Medical Technology: A Primer for Clinical Engineers*, Butterworth-Heinemann; 1992.

**Course Learning Objectives (CLO)**

A student completing this course should at a minimum be able to:

1. Identify roles and responsibilities of biomedical engineers and defend positioning biomedical engineers in advanced tasks
2. Understand national and international standards, and their applications to health care facilities
3. Transform regulations (local and international) governing biomedical engineering practices into policies and procedures
4. Recognize main organizations that have codes for biomedical engineering
5. Design and layout medical facilities, defend the choice of proximity of departments to each other
6. Use software packages like AUTOCAD and MS ACCESS
7. Select and evaluate medical equipment for a specific application
8. Managing the decision process for selecting modalities, sizing, specifying and preparing request for quotation (RFQ) and bill of quantity (BOQ)
9. Prepare bid and evaluate tender
10. Develop processes for receiving, managing and discarding medical equipment
11. Work effectively as a member of biomedical system, facilities design and management team

**Course Topics:** (about 2 weeks for each topic)

1. Responsibilities of biomedical engineers working in health-care facilities.
2. Codes, standards and regulations governing clinical engineering practices.
3. Bids preparation and tender evaluation.
4. Designing and layout of medical facilities.
5. Equipment selection and evaluation.

**Class Schedule:**

Lecture: two one and half hours sessions per week  
Tutorials: one two hours session per week

**Course Contribution to Professional Component:**

Engineering Science: 60%

Engineering Design: 40 %

**Course Relationship to Program Outcomes:**

	<b>Engineering Criteria</b>											<b>Program Criteria</b>					
<b>Program Outcomes</b>	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>P</b>	<b>Q</b>
<b>Average attainable level of learning (*)</b>			<b>H</b>	<b>M</b>	<b>H</b>	<b>M</b>	<b>M</b>			<b>M</b>						<b>M</b>	

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Abdelhameed Al-Khateeb**

**Last Updated: October, 2007**

**EE 499 – SENIOR PROJECT (4,2,4) 4 Credits**  
(Core course)

**Bulletin Description:** Selection of topic: literature review; project design planning, arranging for data collection, and experimental work. Experimental work and data collection or field study (if any). Data processing analysis and results. Preparation of the first draft of final report. Presentation of the project.

**Prerequisites:** EE 321, EE 331, IE 331

**Textbooks:** B. Karagözoğlu, "A Guide to Engineering Design Methodologies and Technical Presentation", KAU Press, 2008.

**References:** None.

**Course Learning Objectives (CLO)**

After finishing the course successfully, the student shall

1. Analyze a project statement, brief, or proposal to identify the real problem and the most relevant needs and operational constraints.
2. Identify potential customers, their needs, and their operational constraints.
3. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources.
4. Integrate previous knowledge from mathematics, basic sciences, engineering fundamentals and discipline related courses to address the problem.
5. Discuss all applicable realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
6. Define design objectives, measures of design viability, and the evaluation criteria of the final project, and reformulate the problem based on collected data.
7. Generate possible solutions; compare alternatives, and select one alternative based on evaluation criteria and feasibility analysis.
8. Plan an effective design strategy and a project work plan, using standard project planning techniques, to ensure project completion on time and within budget.
9. Implement a planned design strategy for an Experimental Design Project, if applicable:
  - 9.1 Identify experimental variables and parameter with ranges and desired accuracies.
  - 9.2 Select appropriate experimental tools such as sensors, instruments, and software.
  - 9.3 Explain a reliable experimental setup and experimental procedure that solves the problem.
  - 9.4 Explain efficient measures to deal responsibly with safety issues and environmental hazards.
  - 9.5 Use appropriate measurement techniques to ethically collect and record data.
  - 9.6 Analyze experimental data using appropriate tools such as data reduction and statistical analysis.
  - 9.7 Perform uncertainty analysis.
  - 9.8 Judge, verify, and validate the experimental result by comparing them with theory and/or previous experimental works.
10. Implement a planned design strategy for a Product-Based Design Project, if applicable:
  - 10.1 Identify design parameters as well as assumptions.
  - 10.2 Carry out initial design calculations using modern engineering tools.
  - 10.3 Use modern engineering tools to estimate the performance parameters of the initial design.
  - 10.4 Use constraint analysis and trade-off studies of the design parameters to refine the initial design and obtain a final optimized design.

- 10.5 Evaluate the project related environmental, social, health and safety issues, as well as hazards anticipated by the project.
- 10.6 Evaluate project success in satisfying customer's needs, design criteria, and operational constraints.
11. Communicate design details and express thoughts clearly and concisely, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.
12. Demonstrate ability to achieve project objectives using independent, well organized, and regularly reported multi-disciplinary team management techniques that integrate, evaluate, and improve different skills of team members.

<b>Course Topics:</b>	<b>Duration in weeks</b>
1. Project selection and team formation	1
2. Problem Definition	2
3. Literature review and data collection	3
4. Problem formulation: <ul style="list-style-type: none"> <li>- Knowledge integration</li> <li>- Operational and realistic constraints</li> <li>- Design objectives</li> <li>- Evaluation criteria</li> </ul>	3
5. Design options and initial layout	2
6. Work plan and budgeting	1
7. Progress report and oral presentation	1
8. Implementation phase	7
9. Design refinement	3
10. Final report and oral presentation	3

**Class Schedule:**

Lecture: 12 1-hour active learning classes

Tutorials/Lab:

**Course Contribution to Professional Component:**

Engineering Science:

Engineering Design: 100 %

**Course Relationship to Program Outcomes:**

<b>P Outcomes</b>	<b>Engineering Criteria</b>											<b>Program Criteria</b>					
	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>	<b>H</b>	<b>I</b>	<b>J</b>	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>P</b>	<b>Q</b>
<b>Average attainable level of learning (*)</b>	M	H	H	H	M	H	H	M	M	M	H	M	M				

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. Bahattin Karagözoğlu**

**Last Updated: June 2008**

**PHY 372 PHYSIOLOGY FOR BIOMEDICAL ENGINEERS (3,3,1) 3 Credits**  
(Core course offered in Spring terms)

**Syllabus:** Body environment, fluids and compartments, digestive system. Metabolism, energetics of glucose metabolism. Respiratory system and artificial respiration. Cardiovascular system and its regulatory mechanism, hemodynamics. Metabolism and body temperature regulation. Endocrinology, reproductive system and renal physiology.

**Prerequisites:** BIO 321

**Textbook:** Chaffee and Lytle, *Basic Anatomy and Physiology*, Lippincott; 4<sup>th</sup> ed, 1980.

**References:** Fox, SI, *Human Physiology*, 2005

**Course Learning Objectives (CLO)**

A student completing this course should at a minimum be able to:

1. Describe in simple terms the normal function of the living organism in terms of its tissues, organs and systems individually and collectively.
2. Describe and discuss the concept of "Normal" and indicate the acceptable ranges for the different functions and functional limits of various systems of the human body under variable physiological conditions.
3. Describe the common factors that may maintain or change the normal functions within the normal range
4. Carryout simple experiments on human subjects or experimental animals or tissues, recording, graphing or tabulating his observations and results and reporting them accurately
5. Perform technical procedures unaided when presented with a programmed schedule of an experiment
6. Carryout simple tests on the functions of the human body or his fluids that are generally practiced in clinical laboratories.
7. Describe the mechanism of the common laboratory equipments and instruments used in such experimental procedure
8. Care, assemble, clean and properly store the laboratory equipments and instruments.
9. Select appropriate sources of information for the promotion of his knowledge.
10. Use the application of the physiological principles and concepts in his future medical technology practice.
11. Maintain a scientific attitude of mind and identify the use of experimental and laboratory procedures in estimating the state of body functions and their derangement both in health and disease.

**Topics:** This course in human physiology for Biomedical Engineering students aims to introduce the students to the Physiological concepts of homeostasis and control mechanisms and to study the functions of body systems with emphasis on clinical relevance. The body systems dealt consist of the autonomic nervous system, excitable tissues, the cardiovascular system, respiration, the blood, the gastrointestinal tract, renal



physiology, introduction to metabolism and body temperature regulation, endocrinology & reproduction, special senses and central nervous system.

1. Introduction to human physiology
2. Autonomic Nervous system
3. Excitable Tissues
4. The Blood
5. Heart and circulation
6. Respiration
7. Gastrointestinal tract
8. Renal functions, micturition & acid base balance
9. Endocrine & Reproduction
10. Metabolism & Body Temperature
11. Special senses
12. Central nervous system

**Class Schedule:**

Lecture: two one and half hours sessions per week

Tutorials: The practical classes (2 hours per week) are going to be utilized in excitable tissue, cardiovascular physiology and respiration in the form of demonstrations. 4 practical sessions will be required by the department of physiology. Total hours for practicals are 2 x 4 = 8 hour per semester

**Course Contribution to Professional Component:**

Engineering Science: 35%  
 Medical Science: 40 %  
 Human and Social Science: 25%

**Course Relationship to Program Outcomes:**

Program Outcomes	Engineering Criteria											Program Criteria					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
Average attainable level of learning (*)		M				M		M				L			L		M

\* L: Objective addresses outcome slightly, M: Moderately, H: Substantially

**Prepared by: Dr. K.A.A Galil**, Department of Physiology, Faculty of Medicine

**Last Updated: October, 2007**