CURRICULUM

OF

ELECTRONIC ENGINEERING

B.Sc. / B.E. & M.Sc. / M.E.

Revised 2008

HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

Curriculum development is a highly organized and systematic process and involves a number of procedures. Many of these procedures include incorporating the results from international research studies and reforms made in other countries. These studies and reforms are then related to the particular subject and the position in Pakistan so that the proposed curriculum may have its roots in the socio-economic setup in which it is to be introduced. Hence, unlike a machine, it is not possible to accept any curriculum in its entirety. It has to be studied thoroughly and all aspects are to be critically examined before any component is recommended for adoption.

In exercise of the powers conferred by sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide notification No. D773/76-JEA (cur.), dated December 4th 1976, appointed the University Grants Commission as the competent authority to look after the curriculum revision work beyond class XII at the bachelor level and onwards to all degrees, certificates and diplomas awarded by degree colleges, universities and other institutions of higher education.

In pursuance of the above decisions and directives, the Higher Education Commission (HEC) is continually performing curriculum revision in collaboration with universities. According to the decision of the special meeting of Vice-Chancellor's Committee, the curriculum of a subject must be reviewed after every 3 years.

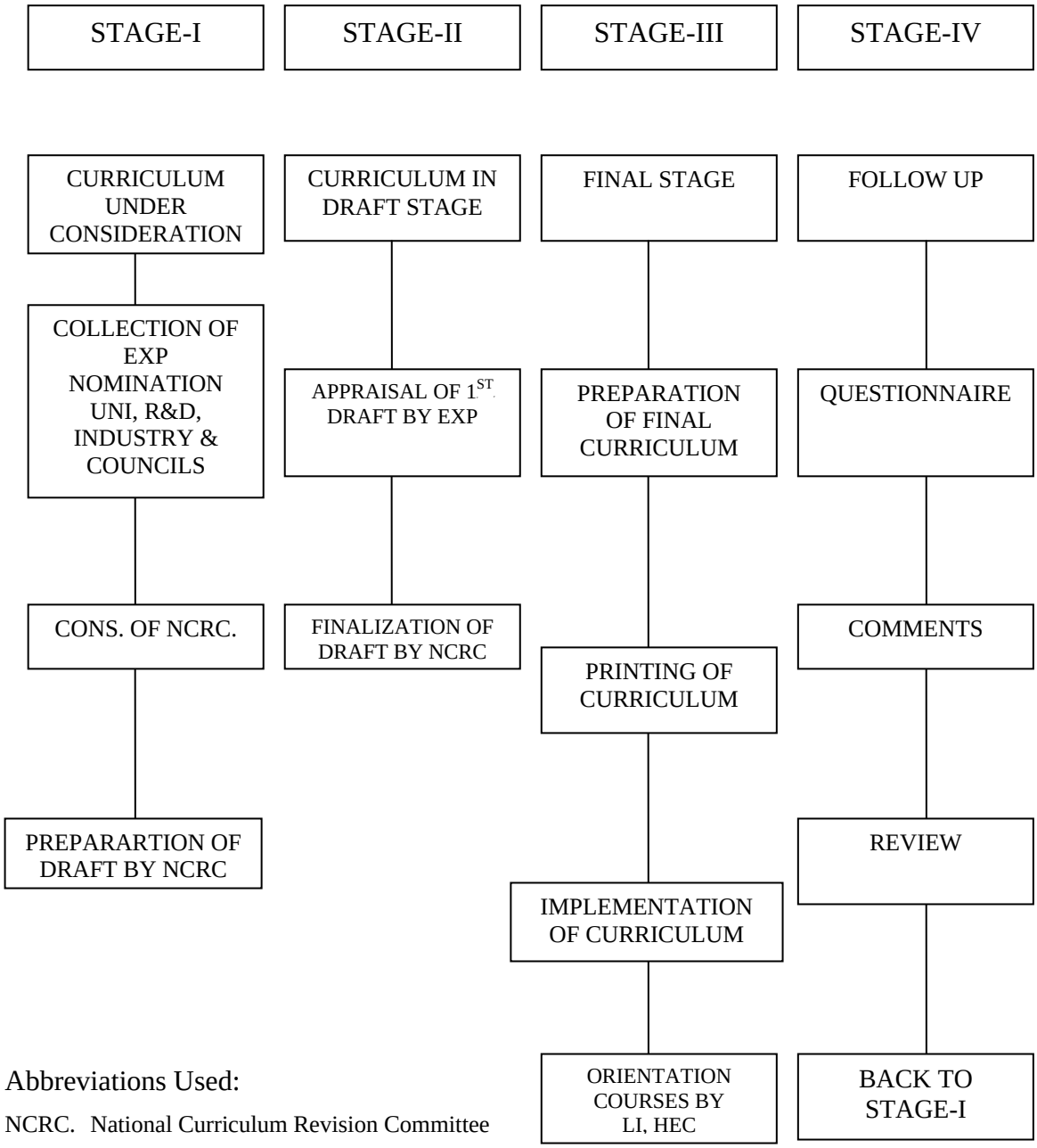
A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic and Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards and to fulfill the needs of the local industries. It also aimed to give a basic and broad-based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4-year duration and will require the completion of 130-136 credit hours. The engineering degree will devote 65-70% of the curriculum towards engineering courses and 35-30% to non-Engineering courses.

For the purpose of curriculum revision, various committees are constituted at the national level comprising of senior teachers nominated by universities, degree awarding institutions, R&D organizations and respective accreditation councils. The National Curriculum Revision Committee on Electronic Engineering, in a special meeting held on February 2008 at Islamabad in continuation of its earlier meetings held on June 19-20, 2007 at the HEC Regional Center, Karachi, revised the curriculum in the light of the unified template. The final draft prepared by the National Curriculum Revision Special Committee, duly approved by the competent authority, is being circulated for implementation in the concerned institutions.

DR.RIAZ-UL-HAQ TARIQ
Member Academics

April 2008

CURRICULUM DEVELOPMENT



Abbreviations Used:

NCRC. National Curriculum Revision Committee

VCC. Vice-Chancellor's Committee

EXP. Experts

COL. Colleges

UNI. Universities

PREP. Preparation

REC. Recommendations

LI Learning Innovation

R&D Research & Development Organization

HEC Higher Education Commission

Introduction

The role of science and engineering in the economic development of a nation and the prosperity of its people is very important and it is imperative for a nation to train its workforce in contemporary science and engineering. At the same time, knowledge is expanding rapidly and new courses and disciplines are emerging at a fast pace. In the light of this situation, it is essential to periodically review and update the science and engineering curricula to stay at par with the international standards. The Higher Education Commission (HEC) ensures that the curricula are reviewed and updated periodically through National Curriculum Revision Committees.

The National Curriculum Revision Committee (NCRC) on Electronic Engineering held two meetings in 2006 to revise the electronic engineering curriculum that was prepared in 2003. In April 2007, the Higher Education Commission approved the new engineering curriculum framework. The National Curriculum Revision Committee held a meeting in June 2007 to bring the electronic engineering curriculum in line with the new framework. The committee held its final meeting in February 2008 at the Higher Education Commission in Islamabad for a final review and approval of the curriculum. The committee, after a thorough review, approved the curriculum in the meeting. The final meeting was chaired by Prof. Dr. Sohail H. Naqvi, Executive Director HEC.

Minutes of the Meeting Held in June 2007

A meeting of the National Curriculum Revision Committee (NCRC) on Electronic Engineering took place on June 19 and 20, 2007, at the Regional Centre of the Higher Education Commission in Karachi. The objective of the meeting was to revise the electronic engineering curriculum to bring it in line with the new engineering curriculum framework approved by HEC in April 2007.

The following members of the committee were present in the meeting:

1. Prof. Dr. Iftikhar A. Khan — Convener
   HEC Foreign Faculty Member
   NWFP University of Engineering and Technology
   Peshawar

2. Prof. Dr. Nasir-ud-Din Gohar — Secretary
   Head of Department, Information Systems Engineering NUST Institute of Information Technology
   166-A, St. 9, Chaklala Scheme III
   Rawalpindi

3. Prof. Dr. Bhawani Shankar Chowdhry — Member
   Chairman, Department of Electronic Engineering
   Mehran University of Engineering and Technology
   Jamshoro

4. Prof. Dr. Abdul Qadir — Member
   Department of Electronic Engineering
   NED University of Engineering and Technology
   Karachi

5. Prof. Dr. Najeeb Siddiqui — Member
   Dean, Faculty of Engineering
   Sir Syed University of Engineering and Technology
   Main University Road
   Karachi

6. Prof. Engr. Hyder Ali Khan — Member
   Consultant, Faculty of Engineering
   International Islamic University
   Islamabad

7. Prof. Mueenuddin Memon — Member
   Department of Electronic Engineering
   Quaid-e-Awam University of Engineering Science and Technology
   Nawabshah

8. Dr. Muhammad Inayatullah Babar — Member
Department of Electrical Engineering
NWFP University of Engineering and Technology
Peshawar

9. Engr. Muhammad Aamir — Member
Assistant Professor
Department of Electronic Engineering
Sir Syed University of Engineering and Technology
Karachi

The meeting started with the recitation from the Holy Quran. Ms. Ghayyur Fatima, Deputy Director (Curriculum), HEC, Islamabad, welcomed the participants on behalf of the Chairman HEC and briefed the participants on the policies of HEC and PEC (Pakistan Engineering Council) about the revision of the engineering curricula in the light of the new framework. The Convener, Prof. Dr. Iftikhar A. Khan, who is also a member of the HEC Committee on Engineering Curriculum Development, briefed the curriculum revision committee on the need to have a new framework for the engineering curricula. He said that the objective of the new framework was to bring the engineering programs at par with the international standards and meet the needs of the industry. He further said that the key considerations in the engineering education should be to give the students a strong engineering foundation, improve their communication skills, develop and promote problem-solving and self-learning skills, and expose the students to the social sciences. The committee, after in-depth discussions, revised the electronic engineering curriculum and brought it in line with the new framework.

At the end of the meeting, Ms. Ghayyur Fatima thanked all members of the committee for their efforts in the revision of the electronic engineering curriculum. The Convener, Prof. Dr. Iftikhar A. Khan, closed the meeting with thanks on behalf of all committee members to HEC for its efforts on the advancement of higher education. He thanked all members of the committee for their dedication and hard work in the revision of the curriculum. He requested the members of the committee to convey his thanks to their respective institutions for support of this task of national importance. Finally, he thanked Ms. Ghayyur Fatima and the staff of the HEC Regional Centre Karachi for their dedicated support of the committee in conducting its business.

Minutes of the Meeting Held in August 2006

A meeting of the National Curriculum Revision Committee (NCRC) on Electronic Engineering took place from August 21 to 23, 2006, at the Regional Centre of the Higher Education Commission in Lahore. The objective of the meeting was to finalize the curriculum prepared in the first meeting of the committee that was held in June 2006.

The following members of the committee were present in the meeting:

1. Prof. Dr. Iftikhar A. Khan — Convener
   HEC Foreign Faculty Member
   NWFP University of Engineering and Technology
   Peshawar
2. Prof. Dr. Nasir-ud-Din Gohar — Secretary
   Head of Department, Information Systems Engineering NUST Institute of Information Technology
   166-A, St. 9, Chaklala Scheme III
   Rawalpindi
3. Prof. Dr. Talat Altaf — Member
   Department of Electrical Engineering
   NED University of Engineering and Technology
   Karachi
4. Prof. Dr. Tahir Izhar — Member
   Department of Electrical Engineering
   University of Engineering and Technology
   Lahore
5. Prof. Dr. Aftab Memon — Member
   Department of Electronic Engineering
   Mehran University of Engineering and Technology
   Jamshoro
6. Prof. Dr. M. Ijaz Sandhu — Member
   Dean, University of South Asia
   47-Tufail Road
   Lahore
7. Prof. Dr. Najeeb Siddiqui — Member
   Dean, Faculty of Engineering
   Sir Syed University of Engineering and Technology
   Main University Road
   Karachi
8. Prof. Engr. Hyder Ali Khan — Member
   Principal, Dawood College of Engineering and Technology
   Karachi

9.	Prof. Mueenuddin Memon Department of Electronic Engineering Quaid-e-Awam University of Engineering Science and Technology Nawabshah	Member
10.	Dr. M. Tahir Khaleeq Deputy Chief Scientist Pakistan Atomic Energy Commission P.O. Box 2191, Islamabad	Member
11.	Dr. Muhammad Inayatullah Babar Department of Electrical Engineering NWFP University of Engineering and Technology Peshawar	Member
12.	Dr. Nisar Ahmed Department of Electronics GIK Institute of Engineering Science and Technology Topi, District Swabi	Member
13.	Engr. Muhammad Aamir Assistant Professor Department of Electronic Engineering Sir Syed University of Engineering and Technology Karachi	Member
14.	Engr. Rifat Mahmood Assistant Professor Electronic and Computer Engineering Department NFC Institute of Engineering and Technological Training Khanewal Road Multan	Member

The meeting started with the recitation from the Holy Quran. Mr. Bashir Ahmed, Deputy Director, HEC Regional Centre, Lahore, welcomed the participants of the meeting on behalf of the Chairman HEC. Before taking up the regular agenda, the committee members sympathized with Prof. Hyder Ali Khan on the sad event of his mother's death and prayed for his mother. Mr. Muhammad Tahir Ali Shah, Assistant Director (Curriculum), HEC, Islamabad, briefed the participants on the policies of HEC and PEC (Pakistan Engineering Council) in relation to the review, revision, and development of curricula. He thanked the members of the committee for their efforts in the preparation of the curriculum. He also thanked the Convener, Prof. Dr. Iftikhar A. Khan, for taking personal interest in the development of the curriculum and for excellent coordination of the efforts of the committee.

At the beginning of the regular agenda, the Convener, Prof. Dr. Iftikhar A. Khan, discussed the curriculum that the committee members had

prepared in the first meeting and thanked the members for providing additional information for the curriculum after the first meeting. He said that one of the tasks of the committee members in the second meeting was to include the course outlines and book recommendations for the elective courses in the graduate curriculum; in the first meeting, the committee members had included only the titles of the graduate elective courses. Prof. Dr. Iftikhar A. Khan said that the presence of the top electronic engineering experts of the country in the meeting provided a unique opportunity to add the course outlines and book recommendations for the graduate elective courses and that this additional information would significantly enhance the usefulness of the curriculum.

The members of the committee who were unable to attend the first meeting were given time to share their thoughts on the draft curriculum prepared in the first meeting; copies of the draft curriculum had been distributed to all members of the committee before the second meeting. This activity was followed by discussion from all members of the committee on the course and lab outlines and book recommendations. The committee members approved the curriculum after in-depth discussions and extensive work on all aspects of the curriculum. The highlights of the curriculum approved by the committee members include the following:

1. Course outlines have been thoroughly reviewed and revised.
2. Course outlines and book recommendations have been added for the graduate elective courses.
3. Lab outlines have been added.
4. Complete information on the recommended books, including the authors, book titles, editions, publication years, publishers, and ISBNs, has been provided.
5. The latest books have been recommended for the courses; books from the 1980s and 1990s that are particularly good have also been recommended for some courses.
6. More core courses of electronic engineering have been added and the number of elective courses has been reduced in the undergraduate curriculum.

At the end of the meeting, Mr. Tahir Ali Shah once again thanked the members of the committee and told them that the committee would remain in effect until a new committee was formed to revise the curriculum.

The Convener, Prof. Dr. Iftikhar A. Khan, closed the meeting with thanks on behalf of all committee members to HEC for its efforts on the advancement of higher education and for providing a platform at the national level to bring together the experts from various institutions to develop the electronic engineering curriculum. He thanked all members of the committee for their dedication, hard work, and excellent teamwork in the preparation of the revised curriculum. He requested the members of the committee to convey his thanks to their respective institutions for support of this task of national importance. Finally, he thanked Mr. Tahir Ali Shah and the staff of the HEC Regional Centre, Lahore, for their dedicated support of the committee in conducting its business.

Sub-Committees of NCRC on Electronic Engineering

The National Curriculum Revision Committee on Electronic Engineering formed the following sub-committees in its first meeting that took place in July 2006 to prepare the draft of the revised curriculum:

Undergraduate Curriculum Sub-Committees

1. Prof. Dr. Iftikhar A. Khan
   Prof. Dr. Tahir Izhar
   Prof. Dr. Najeeb Siddiqui

   Applied Physics, Basic Electrical Engineering, Electrical Machines, Integrated Electronics, Power Electronics, Industrial Electronics

2. Prof. Dr. Aftab A. Memon
   Engr. Muhammad Aamir

   Basic Electronic Engineering, Electronic Circuit Design, Circuit Analysis, Microelectronic Technology, Opto Electronics, VLSI Design, Navigational Aids

3. Dr. M. Tahir Khaleeq
   Engr. Rifat Mahmood

   Computer-Aided Engineering Design, Instrumentation and Measurements, Control Systems, Digital Instrumentation Systems, Introduction to Robotics, Digital Control Systems, Introduction to Neural Networks, Fuzzy Logic and Simulation, Artificial Intelligence, Biomedical Instrumentation, Mechatronics Applications

4. Prof. Dr. Talat Altaf
   Prof. Dr. Nasir-ud-Din Gohar
   Dr. Muhammad Inayatullah Babar

   Introduction to Computers, Data Structures and Programming, Digital Logic Design, Electromagnetic Field Theory, Microprocessors and Microcontrollers, Signals and Systems, Analog and Digital Communications, Digital Signal Processing, FPGA-Based System Design, Laser and Fiber Optics, Optical Communication Systems, Filter Design, Digital Image Processing, Pattern Recognition and Matching, Digital System Design, Operating System Concepts, Computer Communication Networks, Advanced Object-Oriented Programming, Embedded System Design

Graduate Curriculum Sub-Committee

Prof. Dr. Iftikhar A. Khan
Prof. Dr. Tahir Izhar
Prof. Dr. Aftab A. Memon
Prof. Dr. Nasir-ud-Din Gohar
Dr. M. Tahir Khaleeq
Dr. Muhammad Inayatullah Babar
Dr. Nisar Ahmed

Electronic Engineering

Electronic Engineering is an increasingly important engineering discipline that significantly affects the other disciplines of engineering. It is in great demand in both developed and developing nations. Continual advances in electronic engineering in the areas of materials, processes, devices, and circuits have been leading to rapid advances in the existing applications of engineering as well as in the emergence of new applications. To harness the full potential of electronic engineering developments and further advance the state of electronic technology, it is important to have strong programs to educate and train individuals in this key discipline of engineering.

Learning Objectives

The electronic engineering curriculum has been developed with the following objectives in mind:

1. Teach students fundamental and advanced concepts of electronic engineering with particular emphasis on the use of these concepts to further advance the state of electronic technology and meet the needs of industry.
2. Place particular emphasis on communication, problem-solving, and self-study skills.
3. Place particular emphasis on hands-on experience.
4. Train students in effective leadership and decision-making skills.
5. Teach students principles that make them good and responsible engineers and citizens through courses in professional and social ethics, engineering management, and engineering economics.

Expected Outcomes

The proposed curriculum has been designed to produce engineers with the following outcomes:

- The students will be able to analyze and design electronic circuits and systems to meet the current needs of the industry and to commensurate with the future requirements of the country.
- The students will be prepared to be integrated with the policies and planning of the relevant sectors of the government.
- The students will have acquired the knowledge for proper application of electronic devices and systems.
- The students will have acquired the necessary skills to solve problems related to electronic engineering.
- The students will have acquired the knowledge to pursue higher education.

- The students will become familiar with the current trends and advanced techniques currently practiced by the electronic engineers.
- The students will have developed well-balanced personalities with strong leadership and entrepreneurial skills and awareness to socio-economic issues.
- The students will have acquired effective communication skills.

Curriculum Review Basis – Undergraduate Degrees

The curriculum for the undergraduate engineering degree program is based on the following considerations:

Duration

Total duration:	Four (4) calendar years
Total number of semesters:	Eight (8)
Duration of a semester:	> Sixteen (16) weeks of instruction > One (1) to two (2) weeks for examinations

Credit Hours

Total number of credit hours:	130 to 136
Contact hours:	> One (1) contact hour per week for each credit hour of instruction > Three (3) contact hours per week for each credit hour of laboratory work

Course Division

Ratio of Engineering to Non-Engineering courses: (65–70) : (30–35)

Curriculum Review Basis – Graduate Degrees

The curriculum for the graduate engineering degree program is based on the following considerations:

Duration

Total duration:	Two (2) calendar years
Total number of semesters:	Four (4)
Duration of a semester:	> Sixteen (16) weeks of instruction > One (1) to two (2) weeks for examinations

Credit Hours

Total number of credit hours:	> 30 (24 Credit hours of coursework and 6 credit hours of thesis)
Contact hours:	> One (1) contact hour per week for each credit hour of instruction

Scheme of Studies for Undergraduate Degrees
B.Sc. / B.E.

Code	Course Title	Lec[1]	Lab[1]	CR[1]
FIRST YEAR				
BH-100	Functional English	3	0	3
BH-110	Calculus and Analytical Geometry	3	0	3
BH-120	Applied Physics	3	1	4
CS-100	Introduction to Computers	2	1	3
EE-100	Basic Electronic Engineering	3	1	4
	Total	14	3	17

Code	Course Title	Lec	Lab	CR
BH-101	Communication Skills	3	0	3
BH-130	Pakistan Studies	2	0	2
BH-111	Linear Algebra	3	0	3
BH-140	Natural Sciences Elective-I[2]	3	0	3
CS-101	Computer Programming	2	1	3
EE-110	Circuit Analysis-I	3	1	4
	Total	16	2	18
	First Year Credit Hours	30	5	35

Code	Course Title	Lec	Lab	CR
SECOND YEAR				
BH-212	Differential Equations	3	0	3
CS-220	Computer-Aided Engineering Design	0	1	1
EE-201	Electronic Circuit Design	3	1	4
EE-211	Circuit Analysis-II	3	1	4
EE-230	Digital Logic Design	3	1	4
	Total	12	4	16

BH-213	Complex Variables and Transforms	3	0	3
EE-240	Probability and Random Variables	3	0	3
EE-250	Electrical Machines	3	1	4
EE-260	Electromagnetic Field Theory	3	0	3
EE-231	Microprocessors and Microcontrollers	3	1	4
	Total	15	2	17
	Second Year Credit Hours	27	6	33

Code	Course Title	Lec	Lab	CR
THIRD YEAR				
BH-302	Technical Report Writing and Presentation Skills	3	0	3
BH-350	Social Sciences-I[3]	3	0	3
EE-302	Integrated Electronics	3	1	4
EE-341	Signal Processing	3	1	4
EE-370	Instrumentation and Measurements	3	1	4
	Total	15	3	18

BH-331	Islamic Studies	2	0	2
BH-351	Social Sciences-II[3]	3	0	3
BH-341	Natural Sciences Elective-II[4]	3	0	3
EE-380	Analog and Digital Communications (IDEE-I)	3	1	4
EE-390	Control Systems	3	1	4
	Total	14	2	16
	Third Year Credit Hours	29	5	34

Code	Course Title	Lec	Lab	CR
FOURTH YEAR				
MS-400	Engineering Management	3	0	3
EE/CS-4xx	Elective I (Depth I)	3	0	3
EE/CS-4xx	Elective II (Depth II)	3	0/1	3/4
XX-4xx	IDEE-II[5]	3	0/1	¾
EE-499A	Electronic Engineering Project	0	3	3
	Total	12	3/5	15/17

MS-401	Professional and Social Ethics	3	0	3
EE/CS-4xx	Elective III (Depth III)	3	1	4
EE/CS-4xx	Elective IV (Depth IV)	3	0	3
EE-499B	Electronic Engineering Project	0	3	3
	See Note[6]			
	Total	9	4	13
	Final Year Credit Hours	21	7/9	28/30
	Total Program Credit Hours	107	23/25	130/132[6]

1. Lec: Lecture credit hours, Lab: Lab credit hours, CR: Total credit hours
2. Numerical Analysis/Physics II / Chemistry / Biology
3. Courses such as, but not limited to, Sociology, Psychology, Society and Culture, Introduction Anthropology, and Fine Arts
4. Engineering Economics / Biomedical
5. IDEE: Inter-Disciplinary Engineering Elective
6. All universities are encouraged to add a 3 to 4 credit-hour engineering course.

Abbreviations Used:

BH: Basic Sciences and Humanities

CS: Computer Science

EE: Electronic Engineering

MS: Management Sciences

Course Code Methodology:

An educational institution may use the course code methodology used in this document or use its own course code methodology. The course code methodology used in this document is as follows:

- The first two alphabets in a course code indicate the discipline, for example, CS for Computer Science and EE for Electronic Engineering.
- The first digit in the course code indicates the academic year during which the course is offered, for example, 2 in “EE-201” indicates that this course is offered during the second academic year.
- The second digit in the course code indicates the area in a given discipline, for example, the number 0 in “EE-201 Electronic Circuit Design” refers to the first area in electronic engineering. Numbers from 0 to 9 are used to allow up to ten areas in each discipline.
- The third digit of the course code indicates the number of the course in a given area of a discipline, for example, the number 1 in “EE-201 Electronic Circuit Design” indicates that Electronic Circuit Design is the second course in electronic engineering; the first course in this area is Basic Electronic Engineering (EE-100). Again, numbers from 0 to 9 are used to allow up to ten courses in each area of a discipline.
- The course codes for the Electronic Engineering Project are EE-499A and EE-499B.

Scheme of Studies for Undergraduate Degrees in Relation to Curriculum Framework

B.Sc. / B.E.

Code	Course Title	Lec	Lab	CR
FIRST YEAR				
BH-100	Functional English (English-I)	3	0	3
BH-110	Calculus and Analytical Geometry (Math-I)	3	0	3
BH-120	Applied Physics	3	1	4
CS-100	Introduction to Computers (Computing/Fundamentals)	2	1	3
EE-100	Basic Electronic Engineering (Engineering Fundamentals)	3	1	4
	Total	14	3	17

Code	Course Title	Lec	Lab	CR
BH-101	Communication Skills (English-II)	3	0	3
BH-130	Pakistan Studies	2	0	2
BH-111	Linear Algebra (Math-II)	3	0	3
BH-140	Natural Sciences Elective-I	3	0	3
CS-101	Computer Programming (Computing/Programming)	2	1	3
EE-110	Circuit Analysis-I (Engineering Foundation-I)	3	1	4
	Total	16	2	18
	First Year Credit Hours	30	5	35

Code	Course Title	Lec	Lab	CR
SECOND YEAR				
BH-212	Differential Equations (Math-III)	3	0	3
CS-220	Computer-Aided Engineering Design (Computing/Design)	0	1	1
EE-201	Electronic Circuit Design (Engineering Foundation-II)	3	1	4
EE-211	Circuit Analysis-II (Engineering Foundation-III)	3	1	4
EE-230	Digital Logic Design (Engineering Foundation-IV)	3	1	4
	Total	12	4	16

BH-213	Complex Variables and Transforms (Math-IV)	3	0	3
EE-240	Probability and Random Variables	3	0	3
EE-250	Electrical Machines (Breadth-I)	3	1	4
EE-260	Electromagnetic Field Theory (Engineering Foundation-V)	3	0	3
EE-231	Microprocessors and Microcontrollers (Breadth-II)	3	1	4
	Total	15	2	17
	Second Year Credit Hours	27	6	33

Code	Course Title	Lec	Lab	CR
THIRD YEAR				
BH-302	Technical Report Writing and Presentation Skills	3	0	3
BH-350	Social Sciences-I	3	0	3
EE-302	Integrated Electronics (Breadth-III)	3	1	4
EE-341	Signal Processing (Breadth-IV)	3	1	4
EE-370	Instrumentation and Measurements (Breadth-V)	3	1	4
	Total	15	3	18

BH-331	Islamic Studies	2	0	2
BH-351	Social Sciences-II [3]	3	0	3
BH-341	Natural Sciences Elective-II	3	0	3
EE-380	Analog and Digital Communications (IDEE-I)	3	1	4
EE-390	Control Systems (Breadth-VI)	3	1	4
	Total	14	2	16
	Third Year Credit Hours	29	5	34

Code	Course Title	Lec	Lab	CR
FOURTH YEAR				
MS-400	Engineering Management	3	0	3
EE/CS-4xx	Elective I (Depth I)	3	0	3
EE/CS-4xx	Elective II (Depth II)	3	0/1	3/4
XX-4xx	IDEE-II	3	0/1	3/4
EE-499A	Electronic Engineering Project	0	3	3
	Total	12	3/5	15/17

MS-401	Professional and Social Ethics	3	0	3
EE/CS-4xx	Elective III (Depth III)	3	1	4
EE/CS-4xx	Elective IV (Depth IV)	3	0	3
EE-499B	Electronic Engineering Project	0	3	3
	See Note [1]			
	Total	9	4	13
	Final Year Credit Hours	21	7/9	28/30
	Total Program Credit Hours	107	23/25	130 /132 [1]

1. All universities are encouraged to add a 3 to 4 credit-hour engineering course.

Undergraduate Elective Courses

- BH-XXX Numerical Methods (3+0) *
- MS-XXX Engineering Economics (3+0)
- EE-4XX Microelectronic Technology (3+1)
- EE-4XX Power Electronics (3+1)
- EE-4XX Opto Electronics (3+1)
- EE-4XX Digital Instrumentation Systems (3+1)
- EE-4XX Industrial Electronics (3+1)
- CS-4XX Advanced Object-Oriented Programming (3+1)
- EE-4XX VLSI Design (3+1)
- EE-4XX FPGA-Based System Design (3+1)
- EE-4XX Laser and Fiber Optics (3+0)
- EE-4XX Mobile Communications (3+0)
- EE-4XX Satellite Communications (3+0)
- EE-4XX Microwave Engineering (3+1)
- EE-4XX Advanced Communication Systems (3+0)
- EE-4XX Optical Communication Systems (3+0)
- EE-4XX Wave Propagation and Antennas (3+1)
- EE-4XX Navigational Aids (3+1)
- EE-4XX Filter Design (3+1)
- EE/CS-4XX Digital Image Processing (3+0)
- EE/CS-4XX Pattern Recognition and Matching (3+0)
- EE-4XX Introduction to Robotics (3+1)
- EE-4XX Digital Control Systems (3+1)
- EE/CS-4XX Introduction to Neural Networks (3+0)
- EE/CS-4XX Fuzzy Logic and Simulation (3+0)
- EE-4XX Digital System Design (3+1)
- EE-4XX Operating System Concepts (3+0)
- EE/CS-4XX Computer Communication Networks (3+1)
- EE/CS-4XX Artificial Intelligence (3+1)
- EE-4XX Embedded System Design (3+0)
- EE-4XX Biomedical Instrumentation (3+1)
- EE-4XX Mechatronics Applications (3+0)

* – (3 Credit-hour theory + 0 credit-hour lab)

Details of Undergraduate Core Courses

Semester I

BH-100	Functional English	*3 + 0*

Knowledge Area / Sub Area: Humanities / English

Course Outline:

Annex "A"

BH-110	Calculus and Analytical Geometry	*3 + 0*

Knowledge Area / Sub Area: Natural Sciences / Math

Objective: Teach the concepts of calculus and analytic geometry and the applications of these concepts to the solution of engineering problems.

Course Outline:

Introduction to functions, introduction to limit, derivatives and their applications, integral calculus with applications, vector algebra, vector calculus, introduction to analytical geometry, straight line in R3, planes, cylindrical and spherical coordinates, surfaces, cylinders and cones, spheres, spherical trigonometry.

Recommended Books:

- George B. Thomas and Ross L. Finney, "Calculus and Analytic Geometry," Ninth Edition, 1995, Addison-Wesley, ISBN: 0201531747.
- George F. Simmons, "Calculus with Analytic Geometry," Second Edition, 1996, McGraw-Hill, ISBN: 0070576424.
- Gerald B. Folland, "Advanced Calculus," First Edition, First Edition, 2002, Prentice Hall, ISBN: 0130652652.
- Monty J. Strauss, Gerald L. Bradley and Karl J. Smith, "Calculus," 2002, Prentice Hall, ISBN: 0130918717.

BH-120	Applied Physics	*3 + 1*

Knowledge Area / Sub Area: Natural Sciences / Physics

Objective: Teach the fundamentals of classical physics including the electrostatics, electrodynamics, solid-state physics, optics, and thermodynamics in relation to the cooling of electronics.

Course Outline:

Electrostatics: Coulomb's law, electric field and potential, capacitance, dielectrics. Electrodynamics: Magnetic field and force, sources of magnetic field, electromagnetic induction, inductance. Solid-state physics: Crystal lattices, unit cells, energy bands, allowed and forbidden states, conductors, semiconductors, insulators. Semiconductors: Composition, purity, *n*- and *p*-type materials, carrier properties and distribution. Carrier action: Diffusion, drift, generation, recombination. Conductivity, mobility, *p*-*n* junction diode, diode curve, forward-biased diode, reverse-biased diode, bipolar junction transistor

and its biasing, MOSFET and its biasing, Hall effect. Optics: Optical absorption, photo-luminescence, photoconductivity, photoelectric effect, lasers, superconductivity. Heat and Thermodynamics in relation to cooling of electronics.

Lab Outline:

Electric fields, Gauss' law, electric potential, capacitance and dielectrics, current and resistance, magnetic fields, sources of magnetic field, Faraday's law, inductance, direct current circuits, alternating current circuits, diode characteristics, transistor characteristics nature of light, geometric optics, laws of geometric optics, interference of light waves, diffraction, polarization.

Recommended Books:

- David Halliday, Robert Resnick, and Jearl Walker, "Fundamentals of Physics," Seventh Edition, 2005, John Wiley & Sons, ISBN: 0471465097.
- Arthur Beiser, "Schaum's Outline of Applied Physics," Fourth Edition, 2004, McGraw-Hill, ISBN: 0071426116.

CS-100 Introduction to Computers *2 + 1*

Knowledge Area / Sub Area: Computing / Fundamentals

Objective: Teach the structure, operation, programming, and applications of computers.

Course Outline:

History, classification, basic components, CPU, memory, peripheral devices, storage media and devices, physical and logical storage, data organization, file storage, programs and software, system software, application software, operating systems, programming languages, compilation and interpretation, problem specification, algorithms, flow chart, pseudo code, basic programming techniques, data types and declaration, header file and linkage, variables and constants, arrays, input/output, termination, remark, control structures, branching, conditional structures, repetition and loops, basic library functions, social impact of computer age, computers in office, industry and education.

Lab Outline:

Computation of number system, implementation of Boolean functions, basic machines organization including motherboard, memory, I/O cards, networking devices, use of flow charts, introduction to office tools, overview of different browsers including open-source browsers, introduction to various operating systems, coding, executing and debugging simple programs, implementation of simple control structures, implementation of simple functions, implementation of different function styles.

Recommended Books:

- Brian Williams and Stacey Sawyer, "Using Information

Technology," Seventh Edition, 2007, McGraw-Hill, ISBN: 0072260718.

- William Stallings, "Computer Organization and Architecture: Designing for Performance," Seventh Edition, 2006, Prentice Hall, ISBN: 0131856448.

EE-100	Basic Electronic Engineering	*3 + 1*

Prerequisite: BH-120 Applied Physics

Knowledge Area / Sub Area: Engineering Foundation / Engineering Fundamentals

Objective: Introduce the basic concepts of electronics and electronic devices including diodes, transistors, transistor biasing, rectifiers, and amplifiers.

Course Outline:

Introduction to electronics; diodes: *pn* junction diode, forward and reverse characteristics of a diode, ideal diode, practical diode, equivalent circuit of a diode, current equation of a diode, diode as a switch. Types of diodes: Schottky diode, zener diode, tunnel diode, varactor diode, LED, laser diode. Applications of diodes: Half- and full-wave rectifiers, clipper and clamper circuits, voltage multipliers. Bipolar junction transistor: Operation, *npn* and *pnp* transistors, unbiased transistor, DC biasing of a transistor, static characteristics, DC circuit analysis, load line, operating point and bias stabilization. Transistor as an amplifier. Transistor biasing configurations: Common emitter, common base, common collector. Field-effect transistor. FET biasing techniques: Common drain, common source and common gate, fixed bias and self bias configurations, voltage divider biasing. Universal JFET bias curve. Darlington pair.

Lab Outline:

The emphasis is first on understanding the characteristics of basic circuits that use resistors, capacitors, diodes, bipolar junction transistors and field-effect transistors. The students then use this understanding to design and construct more complex circuits such as rectifiers, amplifiers and power supplies.

Recommended Books:

- Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory," Ninth Edition, 2006, Prentice Hall, ISBN: 0131189050.
- Robert Paynter, "Introductory Electronic Devices and Circuits: Electron Flow Version," Seventh Edition, 2006, Prentice Hall, ISBN: 0131716395.

Semester II

BH-101	Communication Skills	*3 + 0*

Knowledge Area / Sub Area: Humanities / English

Course Outline:

Annex “A”

BH-130	Pakistan Studies	*2 + 0*

Knowledge Area / Sub Area: Humanities / Culture

Course Outline:

Annex “B”

BH-111	Linear Algebra	*3 + 0*

Prerequisite: BH-110 Calculus and Analytical Geometry

Knowledge Area / Sub Area: Natural Sciences / Math

Objective: Introduce the matrix theory and the use of matrices in the solution of engineering problems.

Course Outline:

Algebra of matrices; inverse of a matrix; Gauss-Jordan method for the solution of a system of linear algebraic equations; vectors in the plane and in three dimensions; vector spaces; subspaces; span and linear independence; basis and dimension; homogeneous systems; coordinates and isomorphism; rank of a matrix; determinant; inverse of a matrix; applications of determinants; determinants from a computational point of view; properties of determinants; eigenvalues and eigenvectors; systems of linear differential equations; diagonalization; Hermitian matrices; singular value decomposition; quadratic forms; positive definite matrices; non-negative matrices; floating-point numbers; Gaussian elimination; pivoting strategies; matrix norms and condition numbers; orthogonal transformations; eigenvalue problem; least square problems.

Recommended Books:

- Bernard Kolman and David Hill, “Elementary Linear Algebra,” Eighth Edition, 2004, Prentice Hall, ISBN: 0130457876.
- Kenneth Hardy, “Linear Algebra for Engineers and Scientists Using Matlab,” First Edition, 2005, Prentice Hall, ISBN: 0139067280.
- Stephen Goode, “Differential Equations and Linear Algebra,” Second Edition, 2000, Prentice Hall, ISBN: 013263757X.

BH-140	Natural Sciences Elective-I	*3 + 0*

Knowledge Area / Sub Area: Natural Sciences / Electives

Numerical Analysis / Physics-II / Chemistry / Biology / any other universities may recommend any course according to their facility.

CS-101	Computer Programming	*2 + 1*

Prerequisite: CS-100 Introduction to Computers

Knowledge Area / Sub Area: Computing / Programming

Objective: Teach the basic concepts of data structure and its use in computer programs.

Course Outline:

Fundamental data structures, data types, abstract data types, user defined data types, algorithms and their complexity, time-space trade off, arrays, records and pointers, matrices, linked lists, circular lists, two way lists, sequential (array) and linked implementation of stacks and queues, polish notation, recursion, towers of Hanoi, recursive implementation of stacks and queues, priority queues, tree, binary tree, binary search tree, traversals, threaded trees, heap, general trees, graphs, depth-first/breadth first traversal, adjacency matrix, shortest distance algorithms, sorting (insertion sort, selection sort, merge sort, radix sort), hashing, searching (linear search, binary search, depth first/breadth first search).

Lab Outline:

Implementation using simple programs for basic arrays, single-dimensional arrays, two-dimensional arrays, algorithm implementations, implementation of simple data structures like array, implementation of stacks, queues and priority queues, linked list, doubly linked list, circular linked list, tree searching algorithms, hash algorithms implementation, simple sorting techniques including bubble sorting and selection sorting, advanced searching schemes including binary searching and quick searching.

Recommended Books:

- Robert Lafore, “Data Structures and Algorithms in Java,” Second Edition, 2003, Prentice Hall, ISBN: 0672324539.
- Robert Lafore, “Object-Oriented Programming in C++,” Fourth Edition, 2002, Prentice Hall, ISBN: 0672323087.

EE-110	Circuit Analysis-I	*3 + 1*

Knowledge Area / Sub Area: Engineering Foundation / Engineering Foundation-I

Objective: Teach the methods used in the analysis of electrical circuits.

Course Outline:

Physical foundation of electric circuits; electric current; electromotive force; resistance; conventional current; Ohm’s law; work, energy, and power; conductance; efficiency; real and ideal sources; resistive networks; Kirchoff’s voltage and current laws; voltage divider rule; current divider rule; series- and parallel-connected sources; voltage and current source conversions; mesh analysis; nodal analysis; network theorems (Superposition, Thevenin’s, Norton’s, and

Maximum Power Transfer) with independent and dependent sources; capacitance and capacitors; inductance and inductors; electromagnetic induction; alternating current fundamentals; phasor representation of alternating current; AC voltage and current relationships for pure resistance; inductive and capacitive circuits; wye-delta transformations.

Lab Outline:

Study of DC series circuits, parallel circuits, Kirchoff's current and voltage laws, current divider theorem, voltage divider theorem, network theorems, simple RLC circuits, transformer operation, and simulation of basic electrical circuits using PSPICE.

Recommended Book:

- William H. Hayt, Jack Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis," Seventh Edition, 2006, McGraw-Hill, ISBN: 0073263184.
- J. David Irwin and Robert M. Nelms, "Basic Engineering Circuit Analysis," Eighth Edition, 2006, John Wiley & Sons, ISBN: 0470083093.
- Robert L. Boylestad, "Introductory Circuit Analysis," Eleventh Edition, 2004, Prentice Hall, ISBN: 0131730444.

Semester III

BH-212 Differential Equations 3 + 0

Prerequisite: BH-110 Calculus and Analytical Geometry
BH-111 Linear Algebra

Knowledge Area / Sub Area: Natural Sciences / Math

Objective: Introduce differential equations and teach methods to solve these equations.

Course Outline:

Formulation, order, degree, and linearity of a differential equation; complementary and particular solutions; initial- and boundary-value problems; solution of ordinary linear differential equations of first order; Bernoulli's differential equation; solution of ordinary differential equations of second order; origin and formulation of partial differential equations; solutions of first-, second-, and higher-order partial differential equations; homogeneous partial differential equations of order one; Lagrange's method of solution.

Linear equations of second order, such as wave equation and heat equation, used in engineering and physical sciences; solution of such equations using Fourier series; review of power series; series solutions near ordinary points; Legendre equation; types of singular points – Euler's Equation; series solutions near regular singular points; series solutions near regular singular points – the general case. Bessel's Equation and Bessel Functions.

Recommended Books:

- Erwin Kreyszig, "Advanced Engineering Mathematics," Ninth Edition, 2005, International Edition, John Wiley & Sons, ISBN: 0471728977.
- John Polking, Al Boggess, and David Arnold "Differential Equations," Second Edition, 2006, Prentice Hall, ISBN: 0131437380.
- Stephen Goode, "Differential Equations and Linear Algebra," Second Edition, 2000, Prentice Hall, ISBN: 013263757X.

EE-220 Computer-Aided Engineering Design 0 + 1

Knowledge Area / Sub Area: Computing / Design

Objective: Introduce the use of computers in engineering applications. The students will learn the use of a commercial CAD package.

Lab Outline:

Introduction to computer-aided design tools such as AutoCAD, OrCAD and PCAD; computer-aided drafting principles and practices; engineering drawing fundamentals using AutoCAD; drawing of electrical machinery and layouts of electronic assemblies; design and layout of circuit boards using software (PCAD or OrCAD).

Recommended Books:

- Shawna Lockhart, “Tutorial Guide to AutoCAD,” First Edition, 2006, Prentice Hall, ISBN: 9780131713833.
- Muhammad H. Rashid, “Introduction to PSpice Using OrCAD for Circuits and Electronics,” Third Edition, 2004, Prentice Hall, ISBN: 0131019880.

EE-201 Electronic Circuit Design *3 + 1*

Prerequisite: EE-100 Basic Electronic Engineering

Knowledge Area / Sub Area: Engineering Foundation / Engineering Foundation-II

Objective: Teach the operation, analysis, and design of electronic amplifiers and oscillators.

Course Outline:

Amplifier analysis: Transistor as an amplifier, hybrid model of a transistor, small-signal analysis, large-signal analysis, gain calculation of single-stage amplifier, cascading, multistage gain calculations. Classification of amplifiers on the basis of biasing: Class A amplifier, class B amplifier, class AB amplifier, class C amplifier, push-pull amplifier, complementary symmetry amplifier. Classification of amplifiers on the basis of coupling: RC-coupled amplifier, transformer-coupled amplifier, direct-coupled amplifier. Classification of amplifiers on the basis of frequency: Audio-frequency amplifier, radio-frequency amplifier, tuned amplifiers. Feedback: Feedback concept, feedback amplifiers, voltage feedback amplifier, current feedback amplifier. Effect of feedback on frequency response. Practical amplifier considerations: Input and output impedance, amplifier loading, impedance matching. Oscillators: Basic theory, tank circuit, damped and undamped oscillations, phase-shift oscillator, Colpitt oscillator, Hartley oscillator, Wein Bridge oscillator, Clapp oscillator.

Lab Outline:

Transistor curve tracer, introduction to PSPICE and AC voltage dividers, characterization and design of emitter and source followers, characterization and design of AC variable-gain amplifier, design of test circuits for BJTs and FETs, design of FET ring oscillators, design and characterization of emitter-coupled transistor pairs, tuned amplifier and oscillator, design of oscillators.

Recommended Books:

- Thomas Floyd, “Electronics Fundamentals: Circuits, Devices, and Applications,” Sixth Edition, 2004, Prentice Hall, ISBN: 0131111388.
- Thomas Floyd and David Buchla, “Basic Operational Amplifiers and Linear Integrated Circuits,” Second Edition, 1999, Prentice Hall, ISBN: 0130829870.

EE-211 Circuit Analysis-II *3 + 1*

Prerequisites: EE-110 Circuit Analysis-I

Knowledge Area / Sub Area: Engineering Foundation / Engineering Foundation-III

Objective: Teach the methods used in the analysis of electrical circuits.

Course Outline:

Integro-differential equations of circuits; transient analysis; source-free series and parallel RLC circuits; complete response of *RLC* circuit; resonance; lossless *LC* circuit; complex forcing functions; phase relationships for *R*, *L* and *C*; impedance and admittance; sinusoidal steady-state response; quality factor; power factor and power factor improvement; complex frequency; three-phase balanced and unbalanced circuits; three-phase source-load connections; power relationships; magnetically-coupled circuits (mutual inductance, energy considerations, ideal transformers); variable frequency network performance; variable frequency response analysis; sinusoidal frequency analysis; resonant circuits and filter circuits; general two-port networks; impedance and admittance parameters; transmission parameters; hybrid parameters; and interconnection of two port networks.

Lab Outline:

Basic *RL* and *RC* circuits, *RLC* circuit, sinusoidal steady-state analysis, AC power circuit analysis, polyphase circuits, frequency-domain analysis and Bode plots, network analysis in the s-domain, mutual inductance and transformers, two-port networks, circuit analysis techniques using software packages such as PSPICE, Electronic Workbench, Multi-Sim, and Lab View .

Recommended Book:

- William H. Hayt, Jack Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis," Seventh Edition, 2006, McGraw-Hill, ISBN: 0073263184.
- Muhammad H. Rashid, "Introduction to PSpice Using OrCAD for Circuits and Electronics," Third Edition, 2004, Prentice Hall, ISBN: 0131019880.

EE-230 Digital Logic Design *3 + 1*

Knowledge Area / Sub Area: Engineering Foundation / Engineering Foundation-IV

Objective: Introduce the concepts and tools for the design of digital electronic circuits.

Course Outline:

Basic concepts and tools to design digital hardware consisting of both combinational and sequential logic circuits, number systems, Boolean algebra, logic gates, combinational logic design, sequential circuits

and logic design, memory and simple programmable logic devices (SPLDs), introduction to field programmable logic devices (FPLDs)/field programmable gate arrays (FPGAs), introduction to Verilog HDL (VHDL), gate-level and dataflow modeling, use of simulation software such as Veriwell Verilog Simulator.

Lab Outline:

Basic logic gates; Verilog simulation and hardware implementation of combinational circuits such as MUX/DEMUX, encoder/decoder, arithmetic logic unit (ALU); Verilog simulation and hardware implementation of sequential circuits such as flip-flops, registers, shift registers, counters; implementation of logic circuits using SPLDs; project solving a real-life problem.

Recommended Books:

- Morris Mano and Charles R. Kime, “Logic and Computer Design Fundamentals,” Third Edition, 2003, Prentice Hall, ISBN: 013140539X.
- M. Morris Mano, “Digital Design & XILINX 6.3 XSE PKG,” First Edition, 2005, Prentice Hall, ISBN: 0131678485.
- Roger L Tokheim, “Digital Electronics: Principles and Applications,” Student Text with MultiSIM CD-ROM, Sixth Edition, 2002, McGraw-Hill, ISBN: 0078309816.
- Samir Palnitkar, “Verilog HDL,” Second Edition, 2003, Prentice Hall, ISBN: 0130449113.

Semester IV

BH-213	Complex Variables and Transforms	*3 + 0*

Prerequisite: BH-111 Linear Algebra
BH-212 Differential Equations

Knowledge Area / Sub Area: Natural Sciences / Math

Objective: Introduce the concepts of complex variables, Laplace transform, and Fourier transform, and the use of transforms in the solution of engineering problems.

Course Outline:

Introduction to complex number systems, Argand's diagram, modulus and argument of a complex number, polar form of a complex number, De Moivre's theorem and its applications, complex functions, analytical functions, harmonic and conjugate, harmonic functions, Cauchy-Riemann equations, line integrals, Green's theorem, Cauchy's theorem, Cauchy's integral formula, singularities, poles, residues, contour integration and applications; Laplace transform definition, Laplace transforms of elementary functions, properties of Laplace transform, periodic functions and their Laplace transforms, inverse Laplace transform and its properties, convolution theorem, inverse Laplace transform by integral and partial fraction methods, Heaviside expansion formula, solutions of ordinary differential equations by Laplace transform, applications of Laplace transforms; series solution of differential equations, validity of series solution, ordinary point, singular point, Forbenius method, indicial equation, Bessel's differential equation, its solution of first kind and recurrence formulae, Legendre differential equation and its solution, Rodrigues formula; Fourier transform definition, Fourier transforms of simple functions, magnitude and phase spectra, Fourier transform theorems, inverse Fourier transform, solutions of differential equations using Fourier transform.

Recommended Books:

- Erwin Kreyszig, "Advanced Engineering Mathematics," Ninth Edition, 2005, International Edition, John Wiley & Sons, ISBN: 0471728977.

EE-240	Probability and Random Variables	*3 + 0*

Knowledge Area / Sub Area: Engineering Foundation / -

Objective: Introduce the basic concepts and engineering applications of probability and random variables.

Course Outline:

Set theory, basic concepts of probability, conditional probability, independent events, Baye's formula, discrete and continuous random variables, distributions and density functions, probability distributions (binomial, Poisson, hyper geometric, normal, uniform and

exponential), mean, variance, standard deviations, moments and moment generating functions, linear regression and curve fitting, limits theorems, stochastic processes, first and second order characteristics, applications.

Recommended Books:

- Susan Milton and Jesse C Arnold, “Introduction to Probability and Statistics: Principles and Applications for Engineering and the Computing Sciences,” Fourth Edition, 2003, McGraw-Hill, ISBN: 007246836.
- William Mendenhall and Terry Sincich, “Statistics for Engineers and the Sciences,” Fifth Edition, 2007, Prentice Hall, ISBN10: 0131877062.

EE-250 Electrical Machines *3 + 1*

Prerequisite: EE-211 Circuit Analysis-II

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-I

Objective: Teach the concepts, construction, principles of operation, and characteristics of electrical machines.

Course Outline:

Magnetic circuits and calculations: Single-phase and polyphase circuits. Transformers: Principle of operation, construction, types, EMF equation and transformation ratio, equivalent values and equivalent power circuit diagram, impedance matching, operation and phasor diagram with and without load, measurement of losses and efficiency, parallel operation, cooling, three-phase connections, instrumentation transformers; DC machines: Construction, types, armature reaction, no load and on voltage characteristics of series, shunt generators, division of loads in parallel operation, torque speed characteristics, measurement of losses and efficiency. AC machines: AC machine armature winding, three-phase windings, MMF of distributed windings, speed and direction of rotating magnetic field. Induction motor: Types, construction, principle of operation, induced EMF, relation between stator and rotor quantities, phasor diagram, equivalent circuit diagram, torque slip power relations. Synchronous generator. Brushless DC motor. Switched-reluctance motor. Stepper motor.

Lab Outline:

Characteristics of DC series and shunt motors, DC series and shunt generators, AC induction motor, synchronous generator, induction generator, universal motor, brushless DC motor and switched reluctance motor; transformer theory and testing.

Recommended Books:

- A. E. Fitzgerald, Charles Kingsley, Jr. and Stephen D. Umans, “Electric Machinery,” Sixth Edition, 2003, McGraw-Hill, ISBN: 0073660094.
- Stephen J. Chapman, “Electric Machinery Fundamentals,” Fourth

Edition, 2005, McGraw-Hill, ISBN: 0072465239.

- Theodore Wildi, "Electrical Machines, Drives and Power Systems," Sixth Edition, 2006, Prentice Hall, ISBN: 0131776916.

EE-260 Electromagnetic Field Theory *3 + 0*

Prerequisite: BH-213 Complex Variables and Transform

Knowledge Area / Sub Area: Engineering Foundation / Engineering Foundation-V

Objective: Introduce the concepts and mathematical methods to understand and analyze electromagnetic fields and waves.

Course Outline:

Vector analysis, Coulombs law and electric field intensity, Gauss's law, flux density and divergence, energy and potential, conductor dielectric and capacitance, Poisson's and Laplace's equations, steady-state magnetic field, magnetic forces, materials and inductance, time-varying fields and Maxwell's equations, uniform plane waves.

Recommended Books:

- William Hayt and John A. Buck, "Engineering Electromagnetics," Seventh Edition, 2006, McGraw-Hill, ISBN: 0073104639.
- Sadiku, Matthew N, "Elements of Electromagnetics," Second Edition, 1994, Oxford University Press, ISBN: 0195103688.

EE-231 Microprocessors and Microcontrollers *3 + 1*

Prerequisite: EE-230 Digital Logic Design

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-II

Objective: Teach the architecture, programming, interfacing, and applications of microprocessors and microcontrollers.

Course Outline:

Introduction to Intel family microprocessors, instruction set architecture (ISA), assembly language programming, hardware model, read/write cycles, exception/interrupt processing, memory systems, I/O devices, DMA, interfacing to memory and I/O devices, analog-to-digital and digital-to-analog converters, introduction to PIC/Atmel 8051 microcontrollers.

Lab Outline:

Study of 80386 Intel microprocessor ISA using its training boards, implementation of interfacing techniques (using gates, decoders, and SPLDs) to memory system and different I/O devices, learning and implementation of interrupt-driven I/O, learning and implementation of simple microcontroller based circuits, and a mini project.

Recommended Books:

- Barry B. Brey, “The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4,” Seventh Edition, 2006, Prentice Hall, ISBN: 0131195069.
- Douglas V. Hall, “Microprocessor and Interfacing”, Revised Second Edition, 2005, Tata McGraw-Hill, ISBN: 0070601674.
- Han-Way Huang, “PIC Microcontroller: An Introduction to Software & Hardware Interfacing,” First Edition, 2004, Thomson Delmar Learning, ISBN: 1401839673.
- Muhammad Ali Mazidi, Janice Mazidi and Rolin McKinlay, “8051 Microcontroller and Embedded Systems,” Second Edition, 2005, Prentice Hall, ISBN: 013119402X.

Semester V

BH-302	Technical Report Writing and Presentation Skills	*3 + 0*

Knowledge Area / Sub Area: Humanities / English

Course Outline:

Annex “A”

BH-350	Social Sciences -I	*3 + 0*

Knowledge Area / Sub Area: Humanities / Social Sciences

Course Outline:

Courses such as, but not limited to, Sociology, Psychology, Society and Culture, Introduction to Anthropology, Fine Arts, and Inter-Regional Languages or any other course. Details in Annex “C”

EE-302	Integrated Electronics	*3 + 1*

Prerequisites: EE-201 Electronic Circuit Design

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-III

Objective: Teach the analysis and design of digital electronic circuits and operational amplifier, and introduce the fabrication of electronic devices.

Course Outline:

Detailed design of pulse and switching circuits; switch; monostable, astable and bistable circuits; emitter-coupled flip-flop; noise margin; fan-out; propagation delay; Schmitt trigger; saturating and non-saturating logic families (DTL, TTL, ECL, I2L, CMOS); detailed study of timer ICs and their applications; analogue and digital circuit interface with applications; introduction to the fabrication of digital microelectronic pMOS, nMOS, CMOS, and BiCMOS circuits; epitaxy, ion implantation and oxidation; differential amplifiers: DC and AC analysis of differential amplifier; design of simple differential amplifier; level translator; current sources (simple current mirror, Widler and Wilson current source): output stage design; use of op-amp as a circuit element, offset and offset compensation, op-amp with negative feedback, frequency response of an op-amp, DC and AC analysis of op-amp ICs; amplifier; linear and non-linear applications.

Lab Outline:

Comparator analysis, inverting and non-inverting amplifiers, analog-to-digital and digital-to-analog converters, dual regulator, switched-capacitor voltage converter, op-amp DC characteristic measurement, op-amp speed, single-supply op-amp, function generator, phase locked-loop, frequency synthesizer.

Recommended Books:

- Adel S. Sedra and Kenneth C. Smith, “Microelectronic Circuits,”

Fifth Edition, 2003, Oxford University Press, ISBN: 0195142519.

- Thomas L. Floyd and David M. Buchla, “Basic Operational Amplifiers and Linear Integrated Circuits,” Second Edition, 1999, Prentice Hall, ISBN: 0130829870.

EE-341 Signal Processing *3 + 1*

Prerequisite: EE-211 Circuit Analysis-II

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-IV

Objective: Introduce signal processing with an emphasis on digital signal processing and teach the time-domain and frequency-domain analyses of continuous-time and discrete-time systems.

Course Outline:

Types of signals; signal representation and models; system characterization; time domain analysis; frequency domain representation and analysis; continuous-time filters; sampled continuous-time signals; Discrete Fourier transform and its properties; Fast Fourier transform algorithms; inverse transform techniques; implementation of discrete-time systems; DSP chip classifications; DSP block diagram; hardware interfacing techniques of DSP; FIR and IIR filter design using DSP; image processing and other practical applications of DSP.

Lab Outline:

Study of various types of signals; analysis of signals; filter design; analog-to-digital converters; signal sampling using different parameters; MATLAB-based simulation tool box for signal processing; simulation and development of basic signal processing algorithms; study of general signal processing concepts such as sampling, aliasing, quantization, and internal arithmetic operations; signal generation; spectrum estimation and fast transforms; sampling rate conversion and multi-rate processing. Implementation of digital circuits/systems on DSP kits.

Recommended Books:

- Simon Haykin, “Signals and Systems,” Second Edition, 2003, John Wiley & Sons, ISBN: 0471378518.
- John G. Proakis and Dimitris K. Manolakis, “Digital Signal Processing,” Fourth Edition, 2006, Prentice Hall, ISBN: 0131873741.
- Sen M. Kuo and Woon-Seng S. Gan, “Digital Signal Processors: Architecture, Implementation and Applications,” First Edition, 2005, Prentice Hall, ISBN: 0130352144.
- Gordon. E. Carlson, “Signals and Linear System Analysis,” Second Edition, 1998, John Wiley & Sons, ISBN: 0471124656.

EE-370 Instrumentation and Measurements *3 + 1*

Prerequisite: EE-211 Circuit Analysis-II

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-V

Objective: Introduce the concepts and the methods and instruments for the measurement of electrical and non-electrical quantities.

Course Outline:

Precision measurements terminologies including resolution, sensitivity, accuracy, and uncertainty; engineering units and standards; principles of different measurement techniques; instruments for measurement of electrical properties, pressure, temperature, position, velocity, flow rates (mass and volume) and concentration; systems for signal processing and signal transmission; modern instrumentation techniques; static and dynamic responses of instrumentation and signal conditioning; basic data manipulation skills using personal computers and graphs; data acquisition systems; principles of operation, construction and working of different analog and digital meters, oscilloscope, recording instruments, signal generators, transducers, and other electrical and non-electrical instruments; types of bridges for measurement of resistance, inductance, and capacitance; power and energy meters; high-voltage measurements.

Lab Outline:

Design, construction, and analysis of measurement circuits, data acquisition circuits, instrumentation devices, and automatic testing; measurement of electrical parameters using different lab instruments; calibration of measurement instruments; use of data acquisition systems for presentation and interpretation of data; use of microcomputers to acquire and process data; use of simulation and instrumentation languages (LabVIEW).

Recommended Books:

- Klaas B. Klaassen and Steve Gee, “Electronic Measurement and Instrumentation,” 1996, Cambridge University Press, ISBN: 0521477298.
- Kevin James, “PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control,” 2000, Newnes, ISBN: 0750646241.

Semester VI

BH-331	Islamic Studies	*2 + 0*

Knowledge Area / Sub Area: Humanities / Culture

Course Outline:

Annex “D”

BH-351	Social Sciences -II	*2 + 0*

Knowledge Area / Sub Area: Humanities / Social Sciences

Course Outline:

Courses such as, but not limited to, Sociology, Psychology, Society and Culture, Introduction to Anthropology, Fine Arts, and Inter-Regional Languages or any other course. Details at Annex “B”

BH-341	Natural Sciences Elective-II	*3 + 0*

Knowledge Area / Sub Area: Natural Sciences / Electives

Course Outline:

Engineering Economics / Biomedical.

EE-380	Analog and Digital Communications	*3 + 1*

Prerequisite: EE-201 Electronic Circuit Design
EE-341 Signal Processing

Knowledge Area / Sub Area: Inter-Disciplinary Engineering Breadth (Electives) / -

Objective: Develop a fundamental understanding of communication systems with emphasis on signal modulation techniques. Teach both analog techniques (amplitude modulation, frequency modulation) and digital techniques (pulse code modulation, phase shift keying, frequency shift keying).

Course Outline:

Basic definitions; modulation and de-modulation techniques: amplitude, angle, pulse modulation, digital modulation techniques; information theory; error detection and correction; multiplexing techniques; noise and its effects on signal transmission; BER performance of various modulation techniques under noisy environment.

Lab Outline:

Study of different modulation techniques including amplitude modulation, frequency and pulse modulation; study of demodulation techniques; experimental modules for FDM, TDM and PCM; MATLAB/SIMULINK modeling and simulation of a simple transceiver; a mini project is recommended.

Recommended Books:

- B. P. Lathi, “Modern Digital and Analog Communication Systems,” Third Edition, 1998, Oxford University Press, ISBN: 0195110099.
- Leon W. Couch, “Digital and Analog Communication Systems,” Seventh Edition, 2007, Prentice Hall, ISBN: 0131424920.
- John G. Proakis and Masoud Salehi, “Communication Systems Engineering,” Second Edition, 2002, Prentice Hall, ISBN: 0130617938.

EE-390	Control Systems	*3 + 1*

Prerequisite: EE-211 Circuit Analysis-II
EE-341 Signal Processing

Knowledge Area / Sub Area: Major Based Course (Breadth) / Breadth-VI

Objective: Introduce the concepts of open-loop and closed-loop systems and their transfer functions. Teach the methods for the analysis and design of closed-loop feedback systems.

Course Outline:

Introduction to control systems; open-loop and closed-loop systems, transfer functions, block diagrams, signal flow graphs; introduction to modeling; formation of differential equations of electrical, mechanical and other systems, transfer functions; stability, Routh’s stability criterion, types and analysis of feedback control systems; root locus, Bode plots, polar plots, Nyquist stability criterion, gain and phase margins, Nichol’s chart; steady-state and transient response of first-order, second-order and higher-order systems; introduction to state-space concepts and design techniques, formation and solution of state equations, eigenvalues and eigenvectors, transfer function matrices; PID controllers and compensators.

Lab Outline:

Familiarization with MATLAB Control System tool box and MATLAB-SIMULINK tool box; simulation of step response and impulse response with unity feedback using MATLAB; determination of root locus, Bode plot, and Nyquist plot using MATLAB; determination of PI, PD and PID controller action of first-order simulated process.

Recommended Books:

- Katsuhiko Ogata, “Modern Control Engineering,” Fourth Edition, 2002, Prentice Hall, ISBN: 0130609072.
- Benjamin C. Kuo, “Automatic Control Systems,” Eighth Edition, 2003, John Wiley & Sons, ISBN: 0471381489.

Semester VII

MS-400	Engineering Management	*3 + 0*

Knowledge Area / Sub Area: Management Sciences / -

Objective: Teach the principles of management including the management of human resources as well as projects.

Course Outline:

Principles of management; decision making; stress management; conflict management; crisis management; leadership; motivation; delegation of powers; role of projects in organization's competitive strategy, standard methodologies for managing projects, project life cycle, design implementation interface, estimating, contractual risk allocation, scheduling: PBS and WBS, integration of scope, time, resource and cost dimensions of a project; evaluation of labor, material, equipment, and subcontract resources; scheduling techniques such as CPM/PERT and GERT, critical chain, solving real-world project schedules, cost budgeting, cost baseline, cash flow analysis, earned value analysis, cost control, proposal presentation, application of software for project management.

Recommended Books:

- Avraham Shtub, Jonathan F. Bard and Shlomo Globerson, "Project Management: Processes, Methodologies, and Economics" Second Edition, 2005, Prentice Hall, ISBN: 0130413313.

EE/CS-4XX	Elective I	*3 + 0*

Knowledge Area / Sub Area: Major Based Course (Depth) / Depth-I

EE/CS-4XX	Elective II	*3 + 0*

Knowledge Area / Sub Area: Major Based Course (Depth) / Depth-II

XX-4XX	Inter-Disciplinary Engineering Elective	*3 + 0/3*

Knowledge Area / Sub Area: Inter-Disciplinary Engineering Breadth (Electives)/ -

EE-499A	Electronic Engineering Project	*0 + 3*

Knowledge Area / Sub Area: Senior Design Project / -

Course Outline:

This course enables the students to enhance their technical capabilities by implementing their theoretical and practical knowledge in the field of research and development. Students should complete background study and simulation/design of the project.

Semester VIII

MS-401	Professional and Social Ethics	*3 + 0*

Knowledge Area / Sub Area: Management Sciences / -

Objective: Teach the ethical issues of interest to the professional community to produce engineers who are not only good and responsible engineers, but also good and responsible citizens.

Course Outline:

This course introduces contemporary and controversial ethical issues facing the professional community. Topics include moral reasoning, moral dilemmas, law and morality, equity, justice and fairness, ethical standards, and moral development. Upon completion, students should be able to demonstrate an understanding of their moral responsibilities and obligations as members of the workforce and society.

Recommended Books:

- C. Ferrell, John Fraedrich and Linda Ferrell, “Business Ethics: Ethical Decision Making and Cases,” Sixth Edition, 2005, Houghton Mifflin Company, ISBN: 0618395733.
- Mike W. Martin and Roland Schinzinger, “Ethics in Engineering,” Fourth Edition, 2005, McGraw-Hill, ISBN: 0072831154.

EE/CS-4XX	Elective III	*3 + 1*

Knowledge Area / Sub Area: Major Based Course (Depth) / Depth-III

EE/CS-4XX	Elective IV	*3 + 0/3*

Knowledge Area / Sub Area: Major Based Course (Depth) / Depth-IV

EE-499B	Electronic Engineering Project	*0 + 3*

Knowledge Area / Sub Area: Senior Design Project / -

Prerequisite: EE-499A Electronic Engineering Project

Outline:

Hardware and software implementation of project design completed in the previous semester, testing and debugging, project report submission and presentation.

Details of Undergraduate Elective Courses

BH-XXX	Numerical Methods	*3 + 0*

Knowledge Area / Sub Area: Natural Sciences / Electives

Objective: Teach the use of computers for the numerical solution of engineering problems.

Course Outline:

Floating point number system, error analysis, solutions of equations, interpolation, splines, numerical differentiation and integration, numerical methods in linear algebra, systems of linear equations, method of least squares, eigenvalues, eigenvectors, solution of ordinary and partial differential equations. This subject is to be supplemented with extensive computer exercises.

Recommended Books:

- Steven C. Chapra and Raymond P. Canale, "Numerical Methods for Engineers," Fifth Edition, 2006, McGraw-Hill, ISBN: 0073101567.
- Curtis F. Gerald, "Applied Numerical Analysis," Seventh Edition, 2003, Addison Wesley, ISBN: 0321133048.

MS-XXX	Engineering Economics	*3 + 0*

Knowledge Area / Sub Area: Natural Sciences / Electives

Objective: Introduce the concepts of economics that engineers need to know to carry out engineering tasks and projects.

Course Outline:

Basic concepts, engineering economics definition, measures of financial effectiveness, no monetary values. Economic environment: Consumer and producer goods, measures of economic worth, price, supply, demand relationship. Selection between alternatives: Present economy, selection among materials, techniques designs, basic investment philosophy, alternatives having identical lives, alternatives having different lives. Value analysis: Important cost concepts, cost-benefit analysis, feasibility studies, value analysis in designing and purchasing. Linear programming: Mathematical statement of linear programming problems, graphic solution, simplex procedure, duality problem. Depreciation and valuation: Types of depreciation, economic life, profit and interest, returns to capital, discrete and continuous compounding, discounting sinking fund problems. Capital financing and budgeting: Types of ownership, types of stock, partnership and joint stock companies, banking and specialized credit institution. Theory of production: Factors of production, laws of returns, break-even charts and relationships. Industrial relationship: Labor problems, labor organizations prevention and settlement of disputes.

Recommended Books:

- Leland T. Blank and Anthony J. Tarquin, “Engineering Economy,” Sixth Edition, 2004, McGraw Hill, ISBN: 0073205346.

EE-4XX Microelectronic Technology *3 + 1*

Prerequisite: EE-302 Integrated Electronics

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Introduce the techniques and processes used in the fabrication of electronic devices.

Course Outline:

Overview of fabrication of solid-state devices and integrated circuits, introduction to basic electronic components and devices, layouts, unit processes common to all IC technologies such as substrate preparation, oxidation, diffusion and ion implantation, basic silicon processing, process modeling.

Lab Outline:

The students will be taught process modeling using a simulation tool such as SUPREM. The fundamental silicon-based processing such as oxide growth, annealing, diffusion mechanisms, ion implantation and rapid thermal processing, physical vapor deposition and other processes will be modeled using SUPREM. The students will model the device structures, for example, pMOS, and predict their electrical characteristics. In case device processing facilities are available, then the students will conduct the processes to fabricate and test the desired structures.

Recommended Book:

- Charles A. Harper, “Electronic Materials and Processes Handbook,” Third Edition, 2004, McGraw-Hill, ISBN: 0071402144.
- Adel S. Sedra and Kenneth C. Smith, “Microelectronic Circuits,” Fifth Edition, 2003, Oxford University Press, ISBN: 0195142519.

EE-4XX Power Electronics *3 + 1*

Prerequisites: EE-201 Electronic Circuit Design

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the semiconductor devices and circuits for the conversion of electrical power of a given form into a desired form. Introduce the applications of power electronics including rectifiers, inverters, UPS, and motor drives.

Course Outline:

Introduction to power electronics; solid-state devices used in power electronics: power diode, power BJT, power MOSFET, SCR, GTO, IGBT, TRIAC, DIAC; semi-controlled, fully-controlled and uncontrolled rectifiers: single-phase and three-phase, six-pulse, twelve-pulse and twenty-four pulse rectifiers; single-phase and three-phase inverters;

pulse-width-modulated (PWM) inverters; UPS; types of converters; switched mode power supplies, AC and DC motor drives.

Lab Outline:

Design of converters; single-phase and three-phase uncontrolled, half-controlled and fully-controlled rectifiers; buck, boost and polarity inverting converters; flyback converter.

Recommended Books:

- Cyril W. Lander, "Power Electronics," Third Edition, 1993, McGraw-Hill UK, ISBN: 0077077148.
- Muhammad H. Rashid, "Power Electronics: Circuits, Devices and Applications," Third Edition, 2004, Prentice Hall, ISBN: 0131011405.
- Ned Mohan, William P. Robbins and Tore M. Undeland, "Power Electronics: Converters, Applications and Design," Media Enhanced, Third Edition, 2003, John Wiley & Sons, ISBN: 0471429082.

EE-4XX	Opto Electronics	*3 + 1*

Prerequisite: BH-120 Applied Physics

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the electronic devices and techniques used in optical communication.

Course Outline:

Nature of light, basic laws of light, optical fiber, types of optical fiber, fiber material, fabrication and components, laser, threshold condition, laser losses, population inversion and threshold conditions, laser modes, classes of lasers, semiconductor light sources, light emitting diodes, semiconductor laser diodes (SLDs), optical transmitter, optical receivers, wavelength division multiplexing (WDM), FDM versus WDM, WDM multiplexer, benefits of WDM, dense wavelength division multiplexing, optical networks.

Lab Outline:

Optical sources, optical detectors, optical amplifiers, optical transmitters, optical receivers, optical transreceivers, optical fibers, propagation of light through an optical fiber, losses in fiber optic elements, optical modulation, multiplexing, optical systems.

Recommended Book:

- Harold Kolimbiris, "Fiber Optics Communications," First Edition, 2004, Prentice Hall, ISBN: 0130158836.

EE-4XX	Digital Instrumentation Systems	*3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the instrumentation and interfacing techniques for microprocessor-based measurement of quantities.

Course Outline:

Advanced instrumentation techniques; microprocessor-based instrumentation; analog-to-digital and digital-to-analog converters; PC-based instrumentation systems: interfacing techniques, data acquisition software, and virtual Instruments; intelligent instrumentation systems.

Lab Outline:

Laboratory activities include the design, construction, and analysis of microprocessor-based measurement circuits, data acquisition circuits, instrumentation devices, and automatic testing. Use of data acquisition systems for presentation and interpretation of data. Use of microcomputers to acquire and process data. Use of simulation and instrumentation languages (LabVIEW).

Recommended Books:

- Ronald Tocci, Neal Widmer and Greg Moss, "Digital Systems: Principles and Applications," Tenth Edition, 2007, Prentice Hall, ISBN: 0131725793.
- William J. Dally and John W. Poulton, "Digital Systems Engineering," 1998, Cambridge University Press, ISBN: 0521592925.

EE-4XX	Industrial Electronics	*3 + 1*

Prerequisite: EE-4XX Power Electronics

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach various industrial applications of electronics including heating, welding, speed control of electrical machines, photo-electric devices, x-ray, PLCs, and data acquisition.

Course Outline:

Electric heating: Principles and applications; induction and dielectric heating; high-frequency welding. Spot welding control. Industrial control: Speed control of DC, AC, and servo motors. Process control. Measurement of non-electrical quantities: Temperature, displacement, pressure, time, frequency; digital industrial measuring systems. Ultra-sonic generation and applications. X-ray applications in industry. Photo-electric devices. Industrial control using PLCs. Data acquisition. Distributed control system in process industries.

Lab Outline:

Experiments related to the principles of welding and PLCs; speed control of DC, AC, and servo motors;

Recommended Books:

- Frank D. Petruzella, "Programmable Logic Controllers," Third Edition, 2005, McGraw-Hill, ISBN: 0078298520.
- Frank D. Petruzella, "Industrial Electronics," First Edition, 1995, McGraw-Hill, ISBN: 0028019962.

CS-4XX	Advanced Object-Oriented Programming	*3 + 1*

Prerequisite: CS-101 Computer Programming

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Discuss issues around the design and implementation of object oriented languages and explore alternatives.

Course Outline:

Procedural versus object-oriented programming languages, object-oriented design strategy and problem solving, objects and classes, member functions, public and private members, dynamic memory management, constructors and destructors, templates, object encapsulation, derived classes, class hierarchies, inheritance and polymorphism, operator overloading, stream class, practical design through object-oriented programming.

Lab Outline:

Advanced object-oriented programming environment; implementation of object-oriented programs: classes, methods, objects, abstract classes and inheritance; overloading and overriding; class aggregation; implementation of polymorphism; use of constructors; testing and debugging.

Recommended Books:

- Goran Svenk, “Object-Oriented Programming Using C++ for Engineering and Technology,” First Edition, 2003, Thomson Delmar Learning, ISBN: 0766838943.

EE-4XX	VLSI Design	*3 + 1*

Prerequisite: EE-302 Integrated Electronics

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach VLSI system design including system specification, verification, and fabrication.

Course Outline:

Introduction to integrated circuits, IC fabrication, monolithic integrated circuits, introduction to MOS technology, basic electrical properties of MOS and BiCMOS circuits, basic digital building blocks using MOS transistor basic circuit concepts, ultra-fast VLSI circuits and systems and their design.

Lab Outline:

Implementation of VLSI design techniques using VHDL and /or Verilog HDL.

Recommended Book:

- Zainalabedin Navabi, “Verilog Computer-Based Training Course,” First Edition, 2002, McGraw-Hill, ISBN: 0071374736.

EE-4XX	FPGA-Based System Design	*3 + 1*

Prerequisite: EE-230 Digital Logic Design

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the design of digital electronic circuits with field-programmable gate arrays.

Course Outline:

Introduction, digital design and FPGA, FPGA-based system design, manufacturing process, transistor characteristics, CMOS logic gates, wires, registers and RAM, packages and pads, FPGA architectures, SRAM-based FPGAs, permanently-programmed FPGAs, circuit design of FPGA fabrics, architecture of FPGA fabrics, logic design process, combinational network delay, power and energy optimization, arithmetic logic elements, logic implementation using FPGAs, physical design (PnR) for FPGAs, synthesis process, sequential design using FPGAs, sequential machine design process, sequential design style, FSM design, ASM design.

Lab Outline:

Introduction to Verilog HDL, gate-level modeling, data flow modeling, behavioral modeling, design, simulation, synthesis and fitting of combinational circuits, design and implementation of an FSM and memory.

Recommended Books:

- Wayne Wolf, “FPGA-Based System Design,” with CD-ROM, 2004, Prentice Hall, ISBN: 0131424610.
- Samir Palnitkar, “Verilog HDL,” Second Edition, 2003, Prentice Hall, ISBN: 0130449113.
- Michael D. Ciletti, “Advanced Digital Design with the Verilog HDL,” First Edition, 2003, Prentice Hall, ISBN: 0130891614.
- Michael John Sebastian Smith, “Application-Specific Integrated Circuits,” First Edition, 1997, Addison Wesley, ISBN: 0201500221.

EE-4XX	Laser and Fiber Optics	*3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the principles of lasers and the use of lasers and other components in optical fiber communication.

Course Outline:

Optical beams and resonators including ray tracing, optical fiber wave guides, transmission characteristics, optical fiber cables and connection, optical fiber measurement, semiconductor and non-semiconductor lasers, receiver characteristics, Gaussian beam

propagation, stable and unstable resonators; classical theory of spontaneous and stimulated emission including a discussion of homogeneous and inhomogeneous line broadening; laser pumping and population inversion in three level and four level systems; fundamentals of laser oscillation, dynamics and threshold; laser cavity equations; laser spiking and mode competition; Q-switching; active and passive mode locking; injection locking; single frequency operation; introduction to fiber lasers and active optical fiber devices; design considerations of fiber optic communication systems: analog and digital modulator, noise in detection process, BIT error rate (BER); system design; maximum transmission distance due to attenuation and dispersion.

Recommended Books:

- Harold Kolimbiris, "Fiber Optics Communications," First Edition, 2004, Prentice Hall, ISBN: 0130158836.
- Gerd Keiser, "Optical Fiber Communications," Third Edition, 2000, McGraw-Hill, ISBN: 0072360763.

EE-4XX	Mobile Communications	*3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Course Outline:

Refer to the HEC Approved Telecommunication Curriculum, Revised 2004, page 26.

EE-4XX	Satellite Communications	*3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Course Outline:

Refer to the HEC Approved Telecommunication Curriculum, Revised 2004, page 28.

EE-4XX	Microwave Engineering	*3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Course Outline:

Refer to the HEC Approved Telecommunication Curriculum, Revised 2004, page 35.

EE-4XX	Advanced Communication Systems	*3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach advanced concepts in communications systems including digital radio, various types of modulation, time-division multiplexing, satellite systems, cellular communication, GSM and 3G mobiles.

Course Outline:

Introduction to digital communication, Shannon limit for information capacity, digital radio, FSK, PSK, BPSK, QPSK, quadrature amplitude modulation, clock recovery, delta modulation pulse code modulation, adaptive delta modulation PCM, differential PCM, pulse transmission, time division multiplexing, T1 digital carrier system, codecs, frame synchronization, bit interleaving versus word interleaving, history of satellites, orbital satellites, geostationary satellites, orbital patterns, look angles, satellite system link models and parameters, satellite link budget, satellite link equations, satellite multiple access arrangements, FDM/FM satellite systems, multiple accessing, TDM/FM frequency hopping, channel capacity; cellular communication, operation of cellular system, elements of cellular system design specifications, concept of mobility, cell coverage for signal and traffic, cell sites and mobile antennas, trunking theory, blocking probabilities, co-channel interference reduction, handoff strategies, power control, GSM architecture, GSM cell structure, call processing in GSM, 3G mobiles.

Recommended Books:

- Leon W. Couch, “Digital & Analog Communication Systems,” Seventh Edition, 2007, Prentice Hall, ISBN: 0131424920.
- Theodore S. Rappaport, “Wireless Communications: Principles and Practice,” Second Edition, 2002, Prentice Hall, ISBN: 0130422320.
- Jochen Schiller, “Mobile Communications,” Second Edition, 2003, Addison-Wesley, ISBN: 0321123816.
- Timothy Pratt, Charles W. Bostian and Jeremy E. Allnutt, “Satellite Communications,” Second Edition, 2003, John Wiley & Sons, ISBN: 0471429120.

EE-4XX Optical Communication Systems *3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the concepts of optical transmission and networking, optical devices, and optical component technologies.

Course Outline:

Optical transmission system concepts, introduction to optical networking, light propagation in multimode fiber, propagation modes, mode partition noise, reflection and return loss variations, optical devices, optical component technologies, types of optical amplifiers, plastic fiber amplifier, second harmonic generators, splitters and couplers, isolators, polarization control.

Recommended Books:

- Govind P. Agrawal, “Fiber-Optic Communication Systems,” Third Edition, 2002, John Wiley & Sons, ISBN: 0471215716.
- Joseph Palais, “Fiber Optic Communications,” Fifth Edition, 2005,

Prentice Hall, ISBN: 0130085103.

EE-4XX	Wave Propagation and Antennas	*3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Course Outline:

Refer to the HEC Approved Telecommunication Curriculum, Revised 2004, page 22.

EE4XX	Navigational Aids	*3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Introduce the concepts of electronic navigation and teach the operation of electronic navigational systems.

Course Outline:

History of navigation, electronic navigation system terminology used in navigation systems, direction finding, two-way distance ranging, differential distance ranging, principle of working of GPS receiver, basic modules comprising typical radar, basic radar range equation and the impact of various parameters on minimum and maximum ranges, principle of working of a pulse Doppler radar, principle of working of a secondary radar (that is, IFF, Identification of Friend and Foe), instrument landing system (ILS), microwave landing system (MLS), very-high frequency ranging system standardizing agencies, Decca, Loran, Omega, Consol, talking beacons.

Lab Outline:

Analysis of radio wave characteristics, direction finding methods, analysis of radar range performance parameters, experiments using microwave/radar training kits, GPS receiver, interfacing of GPS receiver with computer.

Recommended Books:

- Merrill I. Skolnik, “Introduction to Radar Systems,” Third Edition, 2001, McGraw-Hill, ISBN: 0072881380.
- Jay A. Farrell, “The Global Positioning System & Inertial Navigation,” First Edition, 1999, McGraw-Hill, ISBN: 007022045X.

EE-4XX	Filter Design	*3 + 1*

Prerequisite: EE-341 Signal Processing

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the analysis and design of various types of filters.

Course Outline:

Introduction to filters, active devices used in active filter design, circuit design approach, design of first-order filter sections in cascade, biquad circuit, sensitivity analysis, circuit design with simulated

elements, switched-capacitor filters, discrete-time filters.

Lab Outline:

Design of inverting and non-inverting integration; design of first-order filter sections; design of higher-order filters using first-order sections; second-order filter section design; higher-order filter design using second-order section such as low-pass, band-pass, high-pass, band elimination (Notch Filter) and all-pass filters; design of basic filter response using switch capacitors; filter design using high-frequency models of op-amp, that is, active R and active C filters.

Recommended Books:

- Andreas Antoniou, "Digital Filters," Second Edition, 2000, McGraw-Hill, ISBN: 0072432810.
- B. A. Shenoi, "Introduction to Digital Signal Processing and Filter Design," First Edition, John Wiley & Sons, ISBN: 0471464821.
- M. E. Van Valkenberg, "Analog Filter Design", First Edition, 1982, Oxford University Press, ISBN: 0195107349.

EE/CS-4XX Digital Image Processing *3 + 0*

Prerequisite: EE-341 Signal Processing

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the concepts and techniques of digital image processing including image formation, acquisition, storage, compression, and restoration.

Course Outline:

Image formation process, types of images (infrared, thermal and video range), image segmentation, Hough transform, shape from stereo, motion and shading. Image acquisition techniques, digitization, acquisition flaws, image storage, compression techniques, image transformation (translation, scaling, rotation, stereo, 3D modeling, discrete time description of signals, fast Fourier transform, image enhancement, image histogram, contrast enhancement, histogram manipulation, thresholding, binarization, Grey scale and color images, smoothing, sharpening, edge detection, morphological operators (erosion, dilation, opening, closing) medical axis transform, skeletonization, thinning.

Recommended Books:

- Rafael Gonzalez and Richard Woods, "Digital Image Processing", Second Edition, 2002, Prentice Hall, ISBN: 0201180758.

EE/CS-4XX Pattern Recognition and Matching *3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Enable the students to get hands-on experience in the design, implementation, and evaluation of pattern recognition algorithms.

Course Outline:

Introduction, Bayes decision theory, discriminant functions and decision surfaces, Bayesian classification for normal distributions, estimation of unknown probability density functions, linear discriminant functions and decision hyperplanes, perceptron algorithm, least squares methods, feature selection, preprocessing, feature selection based on statistical hypothesis testing, class separability measures, feature subset selection, optimal feature generation, template matching, similarity measures based on optimal path searching techniques, similarity measures based on correlation.

Recommended Books:

- Sergios Theodoridis and Konstantinos Koutroumbas, "Pattern Recognition", Third Edition, 2006, Academic Press, ISBN: 0123695317.
- Luc Devroye, Laszlo Gyorfi and Gabor Lugosi, "A Probabilistic Theory of Pattern Recognition," 1996, Springer, ISBN 0387946187.

EE-4XX Introduction to Robotics *3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the fundamentals and applications of robots including the robot hardware and design of control laws.

Course Outline:

Introduction to robots, robot fundamentals and applications, classification of robots, robot hardware, robot sensors, robot/system integration; provides a comprehensive treatment of the mathematical modeling of robot mechanisms and the analysis methods used to design control laws for these mechanisms.

Lab Outline:

Experiments to introduce the students to basic robotics and programming of programmable devices used in the robotics field.

Recommended Books:

- J. L. Fuller, "Robotics: Introduction, Programming, and Projects", Second Edition, 1998, Prentice Hall, ISBN: 0130955434.
- David Cook, "Robot Building for Beginners," 2002, Apress, ISBN: 1893115445.
- John J. Craig, "Introduction to Robotics: Mechanics and Control," Third Edition, 2003, Prentice Hall, ISBN: 0201543613.

EE-4XX Digital Control Systems *3 + 1*

Prerequisite: EE-390 Control Systems

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the theory and methods for the analysis and design

of digital control systems including theory of sampling, discrete transfer functions, z transform analysis, and stability.

Course Outline:

Basics of digital control, theory of sampling, sampled data systems, discrete signals and sampling, difference equation, discrete transfer functions, z transform analysis, frequency response methods, state equations, time-discrete representation of time-continuous systems, discrete control algorithms, design methods of digital controllers, stability of digital control systems, discrete equivalents for continuous controllers, pulse transfer functions of feedback systems, digital-to-analog conversion, digital filtering of systems.

Lab Outline:

Control system identification; controller design, experimentation, computer simulation, and analysis of control systems. All experiments are conducted with real-time process interface cards of PC for experimental data display and storage. Stored files are analyzed further using MATLAB. Lab assignments include computer-based control system simulation and design using MATLAB.

Recommended Books:

- Charles L. Phillips and H. Troy Nagle, "Digital Control System Analysis and Design," Third Edition, 1995, Prentice Hall, ISBN: 013309832X.
- Benjamin C. Kuo, "Digital Control Systems," Second Edition, 1995, Oxford University Press, ISBN: 0195120647.
- Mohammed S. Santina, Allen R. Stubberud and Gene H. Hostetter, "Digital Control System Design," Second Edition, 1995, Oxford University Press, ISBN: 0030760127.
- Katsuhiko Ogata, "Discrete-Time Control Systems," Second Edition, 1995, Prentice Hall, ISBN: 0130342815.

EE/CS-4XX	Introduction to Neural Networks	*3 + 0*

Prerequisite: EE-231 Microprocessors and Microcontrollers
EE/CS-4XX Artificial Intelligence

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the basics of neural network technology and the application of this technology to the solution of engineering problems.

Course Outline:

Introduction and benefits of neural networks technology; biological neural morphology: biological neurons, biological neural system; model of single artificial neuron; artificial neural network architecture; learning paradigms: supervised learning, unsupervised learning, reinforcement learning, Hebbian learning, Boltzmann learning; perceptron; multilayer perceptron networks; radial basis function networks; recurrent networks; Hoppfield's network; Adeline networks; simulated annealing; introduction to modular neural networks; neural

networks as a problem solving paradigm; connectionist expert systems; applications of connectionist systems for solving typical problems; familiarization with MATLAB-Neural Networks tool box for problem solving.

Recommended Books:

- Kevin Gurney, “An Introduction to Neural Networks,” 1997, CRC Press, ISBN: 1857285034.
- Simon Haykin, “Neural Networks: A Comprehensive Foundation,” Second Edition, 1999, Prentice Hall, ISBN: 0132733501.
- Martin T. Hagan, Howard B. Demuth and Mark H. Beale, “Neural Network Design,” 2002, Martin Hagan, ISBN: 0971732108.

EE/CS-4XX	Fuzzy Logic and Simulation	*3 + 0*

Prerequisite: EE-231 Microprocessors and Microcontrollers
EE/CS-4XX Artificial Intelligence

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the concepts and techniques of fuzzy logic and the application of fuzzy logic to the solution of engineering problems.

Course Outline:

Introduction and benefits of fuzzy technology, fuzzy sets, fuzzy logic, membership functions, fuzzification, defuzzification, fuzzy logic control, explanation of fuzzy techniques with examples, fuzzy expert systems, familiarization with MATLAB-Fuzzy Logic tool box for problem solving.

Recommended Books:

- Timothy J. Ross, “Fuzzy Logic with Engineering Applications,” Second Edition, 2004, John Wiley & Sons, ISBN: 0470860758.
- Hua Harry Li and Madan M. Gupta, “Fuzzy Logic and Intelligent Systems,” 1995, Springer, ISBN: 0792395751.
- Kazuo Tanaka and T. Niimura, “An Introduction to Fuzzy Logic for Practical Applications,” 1996, Springer, ISBN: 0387948074.

EE-4XX	Digital System Design	*3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the design of digital electronic devices and systems including the use of CAD tools.

Course Outline:

Detailed description and analysis of core digital design block; inverter; implementation of inverter in CMOS; design of more complex combinational gates such as NAND, NOR and EXOR for optimum speed, area, or power; application of learned techniques to more evolved designs such as adders and multipliers; impact of interconnect parasitics on circuit performance and approaches to cope with them; study of sequential circuits; clocking approaches;

memories; examination of design methodologies; use of CAD tools for layout, extraction, and simulation for assignments, labs and projects.

Lab Outline:

Use of SPICE, IRSIM, and Magic SW packages to design, simulate and layout design of inverter, NAND and NOR gates; circuit extraction; switch-level simulation; interconnect-buffer design; mini design project.

Recommended Books:

- Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits," Second Edition, 2002, Prentice Hall, ISBN: 0130909963.
- Neil H.E. Weste and David Harris, "CMOS VLSI Design: A Circuits and Systems Perspective," Third Edition, 2004, Addison Wesley, ISBN: 0321149017.

EE-4XX Operating Systems Concepts *3 + 0*

Prerequisite: CS-100 Introduction to Computers

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the basics and administration of various operating systems including DOS, Windows, and Unix/Linux.

Course Outline:

Overview and history, operating system concepts, DOS, Windows, Unix/Linux, processes and threads, process scheduling, device and file management, memory management, concurrency and deadlocks, Windows systems administration, Unix system administration and shell programming, virtual memory, multiprocessors and real time scheduling, file sharing, servers, distributed processing, process migration.

Recommended Books:

- Andrew Tanenbaum and Albert Woodhull, "Operating Systems Design and Implementation," Third Edition, 2006, Prentice Hall, ISBN: 0131429388.
- Andrew Tanenbaum, "Modern Operating Systems," Second Edition, 2001, Prentice Hall, ISBN: 0130313580.

EE/CS-4XX Computer Communication Networks *3 + 1*

Prerequisite: EE-380 Analog and Digital Communications

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the concepts, techniques, and devices of computer-based communication networks including modulation techniques, multiplexing, digital carrier systems, GSM, TCP/IP, LAN systems, network security, and VoIP.

Course Outline:

Communication concept and terminology, transmission impairments, transmission media (guided and unguided), synchronization code, modulation techniques, error detection, HDLC protocol, multiplexing (FDM and simple TDM), digital carrier systems (ISDN and SONET/SDH), asymmetric digital subscriber line (ADSL), circuit switching, packet switching, routing algorithms, X-25, ATM and frame relay, cellular digital packet data and Global System for Mobile Communication (GSM), network types, network topologies, ISO-OSI model, TCP/IP introduction, LAN Systems (Ethernet, token ring, FDDI), LAN devices (repeaters, hubs, bridges, switches), principles of internetworking, wireless internetworking, IP multicasting, routing protocols, connection oriented protocol, network security requirements, public encryption and digital signatures, network management protocol, e-mail protocols, hyper text transfer protocol, DNS (domain name system) introduction to VoIP.

Lab Outline:

Demonstration of various multiplexing techniques, demonstration of circuit switching and packet switching, TCP/IP modules, small scale network design.

Recommended Books:

- William Stallings, “Data and Computer Communications,” Seventh Edition, 2004, Prentice Hall, ISBN: 0131006819, ISBN: 9780131006812.
- Andrew Tanenbaum, “Computer Networks,” Fourth Edition, 2003, Prentice Hall, ISBN: 0130661023.
- Behrouz A Forouzan, “Data Communications Networking,” Fourth Edition, 2007, McGraw-Hill, ISBN: 0073250325.

EE/CS-4XX Artificial Intelligence *3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the concepts, applications, and methods of artificial intelligence.

Course Outline:

Introduction to artificial intelligence (AI); basic elements of AI; history, applications and classification of techniques used; production systems and search: definition and examples of production systems; state space search: graph theory, strategies (data driven, goal driven), techniques (depth first, breadth first); heuristic search: definitions, techniques; knowledge representation: knowledge representation issues; procedural knowledge representation vs. declarative knowledge; reasoning; facts; representing knowledge using rules; logic programming; common sense and statistical reasoning: nonmonotonic reasoning and modal logic for nonmonotonic reasoning; dealing with agents and their beliefs; use of certainty

factors in rule-based systems; associating probabilities to assertions in first-order logic; Bayesian networks; expert systems: components of expert systems, development methodology (selection of problems, knowledge engineering), types (rule based, model based, case based), knowledge representation (rules, semantic networks, frames), inference, forward chaining, backward chaining, production systems and rule based expert systems; goal-driven problem reasoning; data-driven reasoning.

Lab Outline:

Programming in Prolog or Lisp. Exercises of AI in Prolog or Lisp. Development of expert system.

Recommended Books:

- Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach," Second Edition, 2002, Prentice Hall, ISBN: 0137903952.
- Elaine Rich and Kevin Knight, "Artificial Intelligence," Second Edition, 1990, McGraw-Hill, ISBN: 0070522634.
- R. J. Schalkoff, "Artificial Intelligence in Engineering Approach," 1990, McGraw-Hill, ISBN: 0070550840.
- Peter Jackson "Introduction to Expert Systems," Third Edition, 1998, Addison Wesley, ISBN: 0201876868.
- Ivan Bratko, "Prolog Programming for Artificial Intelligence," Third Edition, 2000, Addison Wesley, ISBN: 0201403757.

EE-4XX	Embedded System Design	*3 + 0*

Prerequisite: CS-100 Introduction to Computers
EE-230 Digital Logic Design

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Introduce the trends and challenges in the design of embedded systems and teach chip technologies and design tools needed for these systems.

Course Outline:

Trends and challenges in embedded system design, introduction to the design and use of single-purpose processors (hardware) and general-purpose processors (software), memories and buses, hardware/software tradeoffs, advanced computation models, control systems, chip technologies, modern design tools, embedded processor selection, hardware/firmware partitioning, glue logic, circuit design, circuit layout, circuit debugging, development tools, firmware architecture, firmware design, and firmware debugging; study of Intel 8051; microcontroller architecture and instruction set.

Each student will be required to build and debug a micro-controller board. The course will culminate with a significant final project which would extend the base microcontroller board completed earlier in the course. Learning may be supplemented with periodic guest lectures

by embedded systems engineers from industry.

Recommended Books:

- Frank Vahid and Tony D. Givargis, “Embedded System Design: A Unified Hardware/Software Introduction,” 2001, John Wiley & Sons ISBN: 0471386782.

EE-4XX Biomedical Instrumentation *3 + 1*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Introduce the concepts of medical and clinical instrumentation and teach the tests and test equipment used in medical care and research.

Course Outline:

Basic concepts of medical and clinical instrumentation; basic concepts of medical diagnosis and statistical analysis; introduction to techniques for the design of biomedical instrumentation including sensors and associated electronics: biopotentials, biosensors, and amplifiers; electrocardiography (ECG), electroencephalography (EEG), electromyography (EMG), electroretinography (ERG); basic concepts of diagnostic ultrasound; plain x-ray; CT, MRI, PET, and SPECT; supporting instrumentation such as incubator, respirator, anesthesia machine and dialysis machine; tests used in medical care and research: cardiovascular, imaging, and blood analysis; electrical safety in hospitals.

Lab Outline:

Design and analysis of medical instrumentation; transducers; biopotential amplifiers; computer interfacing; basic signal processing; low-level measurements; analog-to-digital and digital-to-analog signal conversion; microprocessor- and microcontroller-based biomedical instrumentation; programming.

Recommended Books:

- John G. Webster, “Bioinstrumentation,” 2003, John Wiley & Sons, ISBN: 0471263273.
- R. S. Khandpur, “Biomedical Instrumentation: Technology and Applications,” 2005, McGraw-Hill, ISBN: 0071447849.
- Richard Aston, “Principles of Biomedical Instrumentation and Measurement,” First Edition, 1990, Prentice Hall, ISBN: 0675209439.

EE-4XX Mechatronics Applications *3 + 0*

Knowledge Area / Sub Area: Major Based Core (Depth) / -

Objective: Teach the applications and design of systems that involve the integration of mechanical, electronic, and computer engineering.

Course Outline:

Development of mechatronics theory and applications to systems

dependent upon the integration of mechanical, electronic, and computer engineering; assembly of hardware components to create product designs that fulfill a specified task in a mechatronics system; development of design skills in mechanisms, electronic devices, and software to create, test, and verify system functions.

Recommended Books:

- Godfrey C. Onwubolu, “Mechatronics: Principles and Applications,” 2005, Elsevier Butterworth-Heinemann, ISBN: 0750663790.
- John Billingsley, “Essentials of Mechatronics,” 2006, John Wiley & Sons, ISBN: 047172341X.
- Rolf Isermann, “Mechatronic Systems: Fundamentals,” 2005, Springer, ISBN: 1852339306.
- Devdas Shetty and Richard Kolk, “Mechatronics System Design,” 1997, Thomson-Engineering, ISBN: 0534952852.
- W. Bolton, “Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering,” Third Edition, 2003, Pearson Education, ISBN: 0131216333.

Annex "A"

COMPULSORY COURSES IN ENGLISH FOR BE/BSc IN ENGINEERING DISCIPLINE

Semester I

Functional English

Objectives: Enhance language skills and develop critical thinking.

Course Contents

Basics of Grammar
Parts of speech and use of articles
Sentence structure, active and passive voice
Practice in unified sentence
Analysis of phrase, clause and sentence structure
Transitive and intransitive verbs
Punctuation and spelling

Comprehension
Answers to questions on a given text

Discussion
General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening
To be improved by showing documentaries/films carefully selected by subject teachers

Translation skills
Urdu to English

Paragraph writing
Topics to be chosen at the discretion of the teacher

Presentation skills
Introduction

Note: Extensive reading is required for vocabulary building

Recommended books:

1. Functional English

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
2. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

b) Writing

1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.

c) Reading/Comprehension

1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

d) Speaking

Semester II

Communication Skills

Objectives: Enable the students to meet their real life communication needs.

Course Contents

Paragraph writing
Practice in writing a good, unified and coherent paragraph

Essay writing
Introduction

CV and job application

Translation skills
Urdu to English

Study skills
Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension

Academic skills
Letter/memo writing, minutes of meetings, use of library and internet

Presentation skills
Personality development (emphasis on content, style and pronunciation)

Note: documentaries to be shown for discussion and review

Recommended books:
Communication Skills

a) Grammar

1. Practical English Grammar by A.J. Thomson and A.V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan
3. Study Skills by Riachard Yorky.

Semester III

Technical Writing and Presentation Skills

Objectives: Enhance language skills and develop critical thinking

Course Contents

Presentation skills

Essay writing
Descriptive, narrative, discursive, argumentative

Academic writing
How to write a proposal for research paper/term paper

How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

Technical Report writing

Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended books:
Technical Writing and Presentation Skills

a) Essay Writing and Academic Writing

1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).

2. College Writing Skills by John Langan. Mc=Graw-Hill Higher Education. 2004.

3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

b) Presentation Skills

c) Reading

The Mercury Reader. A Custom Publication. Compiled by norther Illinois University. General Editiors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

Annex "B"

Pakistan Studies (Compulsory)

(A Compulsory Subject for Degree Students)

Introduction / Objectives

Objectives

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. **Historical Perspective**
   a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-i-Azam Muhammad Ali Jinnah.
   b. Factors leading to Muslim separatism
   c. People and Land
      i. Indus Civilization
      ii. Muslim advent
      iii. Location and geo-physical features.

2. **Government and Politics in Pakistan**

   Political and constitutional phases:
   a. 1947-58
   b. 1958-71
   c. 1971-77
   d. 1977-88
   e. 1988-99
   f. 1999 onward

3. **Contemporary Pakistan**
   a. Economic institutions and issues
   b. Society and social structure
   c. Ethnicity
   d. Foreign policy of Pakistan and challenges
   e. Futuristic outlook of Pakistan

Books Recommended

1. Burki, Shahid Javed. *State & Society in Pakistan,* The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. *Issue in Pakistan's Economy.* Karachi: Oxford University Press, 2000.
3. S.M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. *Pakistan Political Roots & Development.* Lahore, 1994.
5. Wilcox, Wayne.*The Emergence of Banglades.,* Washington: American Enterprise, Institute of Public Policy Research, 1972.
6. Mehmood, Safdar. *Pakistan Kayyun Toota,* Lahore: Idara-e-Saqafat-e-Islamia, Club Road, nd.
7. Amin, Tahir. *Ethno - National Movement in Pakistan,* Islamabad: Institute of Policy Studies, Islamabad.
8. Ziring, Lawrence. *Enigma of Political Development.* Kent England: WmDawson & sons Ltd, 1980.
9. Zahid, Ansar. *History & Culture of Sindh.* Karachi: Royal Book Company, 1980.
10. Afzal, M. Rafique. *Political Parties in Pakistan,* Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
11. Sayeed, Khalid Bin. *The Political System of Pakistan.* Boston: Houghton Mifflin, 1967.
12. Aziz, K.K. *Party, Politics in Pakistan,* Islamabad: National Commission on Historical and Cultural Research, 1976.
13. Muhammad Waseem, Pakistan Under Martial Law, Lahore: Vanguard, 1987.
14. Haq, Noor ul. *Making of Pakistan: The Military Perspective.* Islamabad: National Commission on Historical and Cultural Research, 1993.

Annex "C"

COURSES FOR SOCIAL SCIENCE

Sociology and Development

Objectives: The main objective of this course is to apprise potential engineers about social factors that contribute towards enhancing their professional performance for the good of society and the country. This course is culture specific and has to be taught within the context of local and national socio-economic environment. The engineers are expected to supervise several people in different capacities and their understanding about human behaviour is critical for their optimum performance. Modification of human behaviour or getting work done from sub-ordinates and seniors remain a major challenge for all the professional engineers. This course will enhance understanding about the determinants of human behaviour, which ultimately will result in improved individual efficiency.

Course Contents

1. Introduction to Sociology
- 1.1 What is sociology?
- 1.2 Nature, scope, and importance of sociology
- 1.3 Social interactions
- 1.4 Social groups
- 1.5 Social institutions

2. Culture and Related Concepts
- 2.1 Definition of culture
- 2.2 Types of culture
- 2.3 Elements of culture
- 2.4 Role of culture in organization
- 2.5 Socialization and personality

3. Interpersonal Relations
- 3.1 Interpersonal behaviour
- 3.2 Formation of personal attitudes
- 3.3 Language and communication
- 3.4 Motivations and emotions
- 3.5 Public opinion

4. Social Stratification
- 4.1 Factors of social stratification
- 4.2 Caste and class
- 4.3 Power, prestige, and authority
- 4.4 Social mobility
- 4.5 Migration

5. Human Ecology
- 5.1 Ecological processes
- 5.2 Ecosystem and energy
- 5.3 Ecosystem and physical environment
- 5.4 Solid waste disposal
- 5.5 Pollution

6. Population Dynamics
- 6.1 World population growth and distribution
- 6.2 Population dynamics in Pakistan
- 6.3 Causes and consequences of urbanization

6.4 Population policy in Pakistan
6.5 Population and development

7. Community Development

7.1 Meaning, scope, and subject matter of community development
7.2 Processes of community development
7.3 Community development programs in Pakistan
7.4 Community organization and related services
7.5 Cooperation and conflict in community development

8. Deviance and Crime

8.1 Crime as a social and cultural phenomenon
8.2 Crime and social organization
8.3 Organized crime
8.4 Culture based crime
8.5 Economics of crime

9. Sociology of Change and Development

9.1 What is social change and development?
9.2 Dynamics of social change
9.3 Role of NGOs in development
9.4 World system and development
9.5 Gender and development

Recommended Readings

1. *Allport, G. W. (1985). The Historical Background of Modern Social Psychology. New York, Random House.*
2. *Bernard, A. and T. Burgess (2004). Sociology, Cambridge University Press.*
3. *DuBrin, A. J. (2007). Human Relations: Interpersonal Job Oriented Skills. New York, Prentice Hall.*
4. *Gardezi, H. N., Ed. (1991). Understanding Pakistan: The Colonial Factor in Societal Development. Lahore, Maktaba Fikr-o-Danish.*
5. *Hafeez, S. (1991). Changing Pakistan Society. Karachi, Royal Book Company. Gardezi, H. N., Ed. (1991).*
6. *Jones, G. W. (2005). "Why are Population and Development Issues not Given Priority?" Asia-Pasific Population Journal 20(1).*
7. *Macionis, J. J. (1999). Sociology 7th Edition, National Book Foundation, Islamabad*
8. *Maser, C. (1997). Sustainable Community Development: Principles and Concepts. Plorida St. Lucie Press.*
9. *Nelson, N. and S. Wright (1995). Power and Participatory Development: Theory and Practice. London, Intermediate Technology Publications.*
10. *Syed, S. H. (2003). The State of Migration and Multiculturalism in Pakistan: The Need for Policy and Strategy. Islamabad, UNESCO: 1-30.*
11. *Utton, A. E. (1976). Human Ecology, West View Press.*
12. *Webster, A. (1990). Introduction to Sociology of Development. London, Nacmillan Education Ltd.*
13. *Weiss, A. M. (2001). Power and civil society in Pakistan, Oxford University press.*

Social Anthropology

Objectives: The students are expected to learn anthropological skills for application by professional engineers and other related practitioners. Societal growth needs are to be understood within our own cultural environment. Such a body of applied knowledge will result in improving the professional performance of would-be engineers. As culture and society play an important role towards all human activities, this course will help students relate technical skills to the societal needs and requirements.

Course Contents

I Introduction

1. Anthropology and social anthropology
2. Fields of anthropology
3. Anthropological research methods
4. Social anthropology and other social sciences
5. Significance of social anthropology

II Culture

1. Definition, properties and taxomony
2. Evolution of growth and culture
3. Evolution of man: Religious and modern perspectives
4. Evolution of culture
5. Culture and personality

III Evolution and Growth of Culture

1. Evolution of man
2. Schools of thought in cultural anthropology
3. Acculturation
4. Enculturation
5. Ethnocentrism and xenocentrism

IV Language and Culture

1. Communication
2. Structural linguistics
3. Historical linguistics
4. Relationship between language and culture
5. Ethnography

V Economic System

1. Global economic system
2. The allocation of resources
3. The conversion of resources
4. The distribution of goods and services
5. Poverty and inequality

VII Marriage and Family

1. Marriage and mate selection
2. The family: Types and functions
3. Kinship system
4. Structure and function of family
5. Gender Relations

VIII Political Organization

1. Political sociology
2. Origin of political organization and organizational system
3. Types of political organizations
4. Power politics and factionalism in Pakistan
5. Resolution of conflict

IX Religion and Magic

1. The universality of religion
2. Comparative religions
3. Religion and society
4. Religious beliefs and practices
5. Witchcraft and sorcery

XI Culture Change

1. Forms of art
2. Expressive culture
3. Process of cultural change
4. Cultural change in the modern world
5. Cultural change in Pakistani society

Recommended Books

1. *Ahmad, Akbar S. 1990. Pakistani Society, Karachi, Royal Books Co.*
2. *Bernard, H. Russel. 1994. Research Methods in Anthropology, Qualitative and Quantitative Approaches. London: Sage Publications*
3. *Bodley, John H. 1994. Cultural Anthropology, California: Mayfield Publishing Co.*
4. *Brogger, Jan. 1993. Social Anthropology and the Lonely Crowd. New Delhi: Reliance Publishing*
5. *Ember, Carol R. & Ember Melvin. 2005. Anthropology, 11th ed. Englewood Cliffs: Prentice Hall, Ince. Harper and Row*
6. *Harris Marvin. 1987. Cultural Anthropology. New York: Harper and Row*
7. *Harris Marvin. 1985. Culture, People, nature; An Introduction to General Anthropology London: Harper and Row*
8. *Haviland, W. A. (2005). Anthropology: The Human Challenge. New York, Thomson Learning Inc.*
9. *Hertzler J. O. 1981. The Social Structure of Islam. Cambridge: Cambridge University Press.*
10. *Keesing, Roger m. 1998. Cultural Anthropology: A contemporary perspective. 3rd ed. New York: Harcourt Brace College Publishers.*
11. *Kottak, Conard Phillip. 2002. Anthropology: The Exploration of Human Diversity. 9th ed. Boston: McGraw Hill Higher Education.*
12. *Kennedy, Charles H. 1992. Pakistan London: Westview Press,.*
13. *Marron, Stanley. 1057. Pakistani Society and Culture. New Heaven*
14. *Wilson, Richard A. 1996. Human Rights, Culture and Context: Anthropological Perspective. London: Pluto Press.*

Understanding Psychology and Human Behaviour

Course Contents

- What is psychology?
- Nature, scope and application with special reference to Pakistan

- Different schools of psychology
- Methods of psychology
- Learning
- Intelligence and artificial intelligence
- Personality and its assessment
- Understanding maladjustive behaviour
- Positive emotional states and processes
- Stress management and anger management

Books Recommended

1. Atkinson R.C., & Smith E.E. (2000), Introduction to Psychology (13th ed.), Harcourt Brace College Publishers.
2. Fernald, L.D., & Fernald, P.S. (2005), Introduction to Psychology, USA: WMC Brown Publishers.
3. Hergenhahn, B.R. (2001). An Introduction to the History of Psychology, New York: Wadsworth.
4. Goodwin, C.J, (2000) Research in Psychology: Methods and Design, (3rd ed.), New York: John Wiley & Sons.
5. Synder, C.R., & Lopez, S.J. (2007) Positive Psychology, USA, Sage Publications.
6. Allen, B.P. (1997), Personality Theories: Development, Growth and Diversity, (2nd Ed.), Boston: Allyn & Bacon.
7. Cohen, R.J., & Swerdlik, M.E. (2005) Psychological Testing & Assessment (6th ed.), New York: McGraw-Hill.
8. Corcini, R., (2000). Current Psychotherapies. London: Thompson & Co Publishers.
9. Comer, R.J. (2004). Abnormal Psychology, USA: Freeman & Company.
10. Schwartz, B., Wassernman, E., & Robbins, S. (2002), Psychology of Learning and Behaviour, 5th Ed. Norton and Company.

Professional Psychology

Course Contents

- Introduction to professional psychology
- Psychological testing
- Educational psychology
- Industrial/organizational psychology
- Social psychology
- Health psychology
- Clinical psychology
- Positive psychology
- Legal, ethical, and professional issues.

Books Recommended

1. Crow, L., & Crow, A. (2000) Educational Psychology, New Delhi: Eurosia Publishing House Ltd.
2. Spiegel, P.K., & Koocher, G.P. (1998), Ethics in Psychology, New York: Oxford University Press
3. Snyder, C.R., & Lopes, S.J. (2000), Handbook of Positive Psychology, New York: Oxford University Press.

4. Compton, W.C. (2005), Introduction to Positive Psychology, USA, Thomson Wadsworth.
5. Debra, L.N. & James Compbell Quick, (2000) Organizational Behaviour (3rd ed), Cincinnat: South Western.
6. Fred Luthans, Alexander, D.S. & Edwin, A. Locke (2000) (Eds), Handbook of Principles of Organizational Behaviour, London: Blackwell.
7. Brannon, L.& Reist, J. (2000), Health Psychology: An Introduction to Behaviour and Health (4th ed.), USA Wadsworth.
8. Donohue, W. & Ferguson, K. (Eds), (2003), Handbook of Professional Ethics for Psychologists; Issues, Questions and Controversies, London: Sage Publications.
9. Meyers, D. (2005), Social Psychology, 8th Ed. McGraw Hill Inc.
10. Cooper, J. & Hogg, M. (2003) Handbook of Social Psychology, Sage Publications
11. Halgin, R.P., Whitbourne, S.K., & Halgin, R. (2004), Abnormal Psychology: Clinical Perspectives on Psychological Disorders, New York: McGraw Hill.
12. Thorndike R.L., & Hage, E.P. (1995), Measurement and Evaluation in Psychology and Education (4th Ed), New York, MacMillan.

Organizational Behaviour

Course Contents

- Introduction to organizational behaviour
  - Organizational disciplines and topics
  - Psychological perspective
  - Social-psychological perspectives

- Structure and control in organization
  - Introduction
  - Bureaucracy
  - Managerial work
  - Contingency theory
  - Organizational design

- Individual and work learning
  - Learning theories
  - Learning and work

- Stress
  - Types of stress and work
  - Occupational stress management

- Individual differences
  - Personality and its factors
  - Personality dimensions and social learning
  - Intelligence

- Motivation and job satisfaction
  - Needs at work
  - Theories of motivation and job satisfaction
  - Correlates of job satisfaction

- Correlates of job satisfaction

- Group and work
  - Social interaction
  - Dramaturgy and impression management
  - Social skill

- Group and inter-group behaviour
  - Group structure and norms
  - Group processes
  - How throne studies

- Leadership
  - Leadership as an attribute
  - Leadership style

- Patterns of work
  - Work-the classical approach
  - Marx, Weber, and the critique of labor
  - Foucault and disciplinary power

- Conflict and consent in work
  - The labor process debate
  - Work place control and resistance
  - Industrial conflict and industrial relations

- Organizational culture
  - Organizational culture and strategic management
  - Exploring organizational culture
  - Evaluating concept of culture

Books Recommended:

1. Finchan, R., & Rhodes, P. (2003), Principles of Organizational Behaviour, 3rd. Oxford.
2. Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. (2006), Human Resource Management, 5th. ed., McGraw Hill.
3. Newstrom John W. (2007), Organizational Behaviour, (12th. Ed), McGraw Hill.
4. Luthan Fred, (2005), Organizational Behaviour, McGraw Hill Inc.
5. Robins, Stephen, (2005), Organizational Behaviour, McGraw Hill Inc.

INTRODUCTION TO SOCIOLOGY

Course Contents

- The Nature of sociology
  - The study of social life
  - Exploring the global village
  - Sociology as a science
  - The sociological imagination
  - The development of sociology
  - Pioneers of sociology

- Nature, scope and subject matter of sociology
- Brief historical development of sociology
- Society and community
- Relationship with other social sciences
- Social interaction processes

- Social groups
  - Definition and functions
  - Types of social groups

- Social institutions
  - Definition
  - Structure and function of social institutions
  - Inter-relationships among various social institutions

- Culture and related concepts
  - Definition and aspects of culture
  - Elements of culture
  - Organization of culture
  - Other concepts, cultural relativism, sub cultures, ethnocentrism, culture lag

- Socialization and personality
  - Role and status
  - Socialization
  - Culture and personality

- Deviance and social control
  - Definition and types of deviance
  - Juvenile delinquency
  - Formal and information methods of social control

- Social stratification
  - Approach to study social stratification
  - Caste class and race as basics of social stratification

- Major perspectives in sociology
  - Functionalist perspective
  - Conflict perspective
  - Interactionstic perspective

- Social control and deviance
  - Agencies of social control

- Social stratification
  - Determinants of social stratification
  - Social mobility, types and definition
  - Dynamics of social mobility

- Concept of social movement
  - Theories of social movement
  - Social and cultural change

- Social and cultural change

- Definition of social change
- Dynamics of social change
- Impact of globalization on society and culture
- Resistance to change

- Collective behaviour
  - Definition
  - Characteristics
  - Causes
  - Types
  - Social movements
  - Mob and crowd behaviour

Books Recommended

1. Neulreck, Kenneth, J. 2005, Sociology: Diversity, Conflict and Change, Boston
2. Barnard, Andy. 2004. Sociology, Cambridge University Press
3. Giddens, Anthony, 2004, Sociology 4th edition, Cambridge Polity Press
4. Albrow, Martin, 2003, Sociology, London Routledge.
5. Richard, T. Schaefer, 2003, Sociology5th edition, McGraw Hill College
6. Kendall, Diana, 2004. Sociology in our Times, 4th ed, Wadsworth
7. Tyler Melissa, Wallace Claire & Abbott Pamela, 2005, An Introduction to Sociology, 3rd ed. Routledge.

Critical Thinking

Course Contents

- The Power of critical thinking
  - Claims and reasons
  - Reasons and arguments
  - Arguments in the rough

- The Environment of critical thinking
  - Perils of haunted mind
  - Self and the power of the group
  - Subjective and social relativism
  - Skepticism

- Making sense of arguments
  - Arguments basics
  - Patterns
  - Diagramming arguments
  - Assessing long arguments

- Reasons for belief and doubt
  - Conflict experts and evidence
  - Personal experience
  - Fooling ourselves
  - Claims in the news

- Faulty reasoning
  - Irrelevant premises
  - Genetic fallacy, composition, division

- Appeal to the person, equivocation, appeal to popularity
- Appeal to tradition, appeal to ignorance, appeal to emotion
- Red herring, straw man

- Unacceptable premises
  - Begging the question, false dilemma
  - Slippery slope, hasty generalization
  - Faulty analogy

- Deductive reasoning: Propositional logic
  - Connectives and truth values
  - Conjunction, disjunction, negation
  - Conditional, checking for validity
  - Simple arguments, tricky arguments
  - Streamlined evaluation

- Deductive reasoning: Categorical logic
  - Statements and classes
  - Translations and standard form
  - Terms, quantifiers
  - Diagramming categorical statements
  - Sizing up categorical syllogisms

- Inductive reasons
  - Enumerative induction
  - Sample size, representativeness, opinion polls
  - Analogical induction
  - Casual arguments, testing for causes
  - Casual confusions

- Inference to the best explanation
  - Explanations and inference
  - Theories and consistency
  - Theories and criteria
  - Testability, fruitfulness, scope, simplicity
  - Conservatism

- Judging scientific theories
  - Science and not science
  - The scientific method, testing scientific theories
  - Judging scientific theories
  - Copernicus versus Ptolemy, evolution versus creationism
  - Science and weird theories
  - Making weird mistakes
  - Leaping to the weirdest theory, mixing what seems with what is
  - Misunderstanding the possibilities
  - Judging weird theories
  - Crop circles, talking with the dead

BOOKS RECOMMENDED

1. Vaughn Lewis, 2005, The Power of Critical Thinking, Oxford University Press.

2. Paulsen David W., Cederblom Jerry:2000, Critical Reasoning, Wadsworth
3. Restall Greg. 2005, Logic: An Introduction, Routledge

Introduction To Philosopy

Course Contents

- Definition and nature of philosophy
- Theory of knowledge
  - Opinion and knowledge
  - Plato, the republic selection
  - Knowledge through reason
  - Descartes meditation on first philosophy
  - Knowledge through experience
  - Hume an Inquiry concerning human understanding (Selection)
  - Experience structured by the mind
  - Kant critique of pure reason (Selection)
  - Knowing and doing
  - James pragmatism (Selection)
  - Knowledge and emotion
  - Jaggar love and knowledge (Selection)

- Philosophy of religion
  - Proving the existence of God
  - Anselm, Aquinas, Paley, Dawkins (Selection)
  - Justifying religious beliefs
  - Pascal Pensees (Selection)
  - James The will to believe selection
  - Freud The future of an illusion (Selection)
  - Confronting the problems of evil
  - Mackie Evil and omnipotence (Complete)
  - Hick Philosophy of religion (Selection)

- Metaphysics
  - Idealism and materialism
  - Berkeley Three dialogues between Hylas and Pholonous (Selection)
  - Armstrong Naturalism, materialism and first philosophy (Selection)
  - The mid-body problem
  - Descartes Meditations on first philosophy (Selection)
  - O'Hear Introduction to the philosophy of science (Selection)
  - Dennett The origins of selves (Complete)
  - Pali Canon (Selection)
  - Penelhum Religion and rationality (Selection)

- Freedom to Choose
  - Libertarianism
  - James The dilemma of determinism (Selection)
  - Taylor Metaphysics (Selection)
  - Determinism
  - Hospers Meaning and free will (Selection)
  - Skinner Walden Two (Selection)
  - Compatibilism

- Stace Religion and the modern mind (Selection)
- Radhakrishnan Indian philosophy (Selection)

- Ethics
  - Fulfilling Human Nature
  - Aristotle Nicomachean Ethics (selection)
  - Loving God
  - Augustine The Morals of the Catholic Church and the City of God (Selection)
  - Following Natural Law
  - Aquinas Summa Theologiae (Selection)
  - Doing One's Duty
  - Kant Fundamental Principles of the Metaphysics of Morals (Selection)
  - Maximizing Utility
  - Mill Utilitarianism (Selection)
  - Turning Values of Upside Down
  - Nietzsche Human, All too Human and Beyond Good and Evil (Selection)
  - Creating Ourselves
  - Sartre Existentialism is a Humanism (Selection)
  - Hearing the Feminine Voice
  - Gilligan In a Different Voice (Selection)
  - Baier What do Women Want in a Moral Theory (Selection)

- Political and Social Philosophy
  - The State as Natural
  - Plato the Republic (Selection)
  - Aristotle Politics (Selection)
  - The State as a Social Contract
  - Hobbes Philosophical Rudiments Concerning Government and Society (Selection)
  - Locke the Second Treatise of Government (Selection)
  - Liberty of the Individual
  - Mill On Liberty (Selection)
  - Alienation in Capitalism
  - Marx Economic and Philosophic Manuscripts of 1844 (Selection)
  - Justice and Social Trust
  - Rawls A Theory of Justice (Selection)
  - Nozick Anarchy, State, and Utopia (Selection)
  - Held Rights and Goods (Selection)
  - Women in Society
  - Wollstonecraft A Vindication of the Rights of Women (Selection)
  - De Behaviour The Second Sex (Selection)
  - The Value of Philosophy
  - Russel The Problems of Philosophy (Selection)
  - Midgley Philosophical Plumbing (Selection)

BOOKS RECOMMENDED

1. Abel Donald C., Stumpf Samuel Enoch, 2002. Elements of Philosophy: An Introduction, 4th Ed. McGraw Hill.
2. Scruton Roger, 2001. A short History of Modern Philosophy, 2nd ed. Routledge.

MANAGEMENT COURSES

Entrepreneurship

Objective:

Entrepreneurship is an important component in the process of economic development. The purpose of this course is to analyse the theories of entrepreneurship and to go for case studies of successful entrepreneurs.

Course Contents:

Introduction: The concept of entrepreneurship, The economist view of entrepreneurship, The sociologist view, Behavioural approach, Entrepreneurship and Management

The Practice of Entrepreneurship: The process of entrepreneurship, Entrepreneurial Management, The entrepreneurial business, Entrepreneurship in service institutions, The new venture

Entrepreneurship and Innovation: The innovation concepts, Importance of innovation for entrepreneurship, Sources of innovative opportunities, The innovation process, Risks involved in innovation

Developing Entrepreneur: Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, The environment, Socio cultural factors, Support systems

Entrepreneurship Organization: Team work, Networking organization, Motivation and compensation, Value system

Entrepreneurship and SMES: Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs

Entrepreneurial Marketing: Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design

Entrepreneurship and Economic Development: Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, The Japanese experience

Case Studies of Successful Entrepreneurs

Text Books:

- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship

- P.N. Singh: Entrepreneurship fo0r Economic Growth
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker
- John B. Miner: Entrepreneurial Success

Principles Of Management

Objectives:

This is a rudimentary course for the students of business administration. The focus of attention will be given to learning fundamental principles of management and of managing people and organization in a historical as well as contemporary world. Students are expected to develop analytical and conceptual framework of how people are managed in small, medium and large public and private national and international organizations.

Course Contents:

- Introduction, overview and scope of discipline
- The evolution and emergence of management thought
- Management functions
- Planning concepts, objectives, strategies and policies
- Decision making
- Organizing; departmentalization, line/staff authority, commitments and group decision making
- Staffing: principles of selection, performance, career planning
- Leading: Motivation, leadership, communication
- Controlling: the system and process and techniques of controlling
- Management and Society: future perspective

Text Books:

- Stephen P. Robins, Mary Coulter: Management
- H. Koontz Odonnel and H. Weihrich: Management
- Mc Farland: Management: Foundation and Practice
- Robert M. Fulmer: The New Management

ANNEX- 'D'

ISLAMIC STUDIES

(Compulsory)

Objectives:

This course is aimed at:

1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
4 To enhance the skill of the students for understanding of issues related to faith and religious life**.**

DETAIL OF COURSES

INTRODUCTION TO QURANIC STUDIES

1) Basic Concepts of Quran
2) History of Quran
3) Uloom-ul -Quran

STUDY OF SELLECTED TEXT OF HOLLY QURAN

1) Verses of Surah Al-Baqra Related to Faith(Verse No-284-286)
2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
5) Verses of Surah Al-Inam Related to Ihkam(Verse No-152-154)

STUDY OF SELLECTED TEXT OF HOLLY QURAN

1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.)
2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14)

SEERAT OF HOLY PROPHET (S.A.W) I

1) Life of Muhammad Bin Abdullah (Before Prophet Hood)
2) Life of Holy Prophet (S.A.W) in Makkah
3) Important Lessons Derived from the life of Holy Prophet in Makkah

SEERAT OF HOLY PROPHET (S.A.W) II

1) Life of Holy Prophet (S.A.W) in Madina
2) Important Events of Life Holy Prophet in Madina
3) Important Lessons Derived from the life of Holy Prophet in Madina

INTRODUCTION TO SUNNAH

1) Basic Concepts of Hadith
2) History of Hadith
3) Kinds of Hadith
4) Uloom –ul-Hadith
5) Sunnah & Hadith
6) Legal Position of Sunnah

SELLECTED STUDY FROM TEXT OF HADITH

INTRODUCTION TO ISLAMIC LAW & JURISPRUDENCE

1) Basic Concepts of Islamic Law & Jurisprudence
2) History & Importance of Islamic Law & Jurisprudence
3) Sources of Islamic Law & Jurisprudence
4) Nature of Differences in Islamic Law
5) Islam and Sectarianism

ISLAMIC CULTURE & CIVILIZATION

1) Basic Concepts of Islamic Culture & Civilization
2) Historical Development of Islamic Culture & Civilization
3) Characteristics of Islamic Culture & Civilization
4) Islamic Culture & Civilization and Contemporary Issues

ISLAM & SCIENCE

1) Basic Concepts of Islam & Science
2) Contributions of Muslims in the Development of Science
3) Quranic & Science

ISLAMIC ECONOMIC SYSTEM

1) Basic Concepts of Islamic Economic System
2) Means of Distribution of wealth in Islamic Economics
3) Islamic Concept of Riba
4) Islamic Ways of Trade & Commerce

POLITICAL SYSTEM OF ISLAM

1) Basic Concepts of Islamic Political System
2) Islamic Concept of Sovereignty
3) Basic Institutions of Govt. in Islam

ISLAMIC HISTORY

1) PERIOD OF KHLAFT-E-RASHIDA
2) PERIOD OF UMMAYYADS
3) PERIOD OF ABBASIDS

SOCIAL SYSTEM OF ISLAM

1) BASIC CONCEPTS OF SOCIAL SYSTEM OF ISLAM
2) ELEMENTS OF FAMILY
3) ETHICAL VALUES OF ISLAM

REFERENCE BOOKS:

1) Hameed ullah Muhammad, "**Emergence of Islam**" , IRI, Islamabad
2) Hameed ullah Muhammad, "**Muslim Conduct of State**"

3) Hameed ullah Muhammad, '**Introduction to Islam**
4) Mulana Muhammad Yousaf Islahi,"
5) Hussain Hamid Hassan, **"An Introduction to the Study of Islamic Law"** leaf Publication Islamabad, Pakistan.
6) Ahmad Hasan, **"Principles of Islamic Jurisprudence"** Islamic Research Institute, International Islamic University, Islamabad (1993)
7) Mir Waliullah, **"Muslim Jrisprudence and the Quranic Law of Crimes"** Islamic Book Service (1982)
8) H.S. Bhatia, **"Studies in Islamic Law, Religion and Society"** Deep & Deep Publications New Delhi (1989)
9) Dr. Muhammad Zia-ul-Haq, **"Introduction to Al Sharia Al Islamia"** Allama Iqbal Open University, Islamabad (2001)

RECOMMENDATIONS

Any curriculum needs its implementation in its true spirit to achieve its objectives. The National Curriculum Revision Committee on Electronic Engineering has the following recommendations in this regard:

- The faculty members should pay particular attention to the development of problem-solving skills in the students from the first semester. Special assignments and projects may be stressed to achieve this objective. It should be emphasized that the objective of the course and laboratory work is to develop the skills that enable the students to solve real-life problems.
- The development of independent thinking and leadership skills is very important. The faculty members should keep this objective in mind in the course and laboratory work, and particularly in the projects.
- The projects should involve analysis, design, and hardware, and the faculty members should encourage the students to select projects from the industry.
- The students should be required to make presentations on their projects and the people from the industry should be invited to these presentations.
- The students should get practical experience during the course of studies. The educational institutions and faculty members should help the students to get meaningful internships in the government and industry. A formal procedure should be established which engages both faculty members and relevant people from the government and industry to review the progress of the students. The students should be required to write reports and give presentations at the end of their internships.
- The core courses are recommended to be included in the curricula in all universities of Pakistan and a set of electives may be chosen to fulfill the complete curriculum requirements. The electives proposed by the committee may not be considered as complete. Universities may introduce additional electives according to the areas of expertise of their faculty members and research facilities.
- All undergraduate subjects may not be coupled with laboratories. Laboratories may be offered as separate courses and should cover the scope of more than one course. However, the courses, which cannot be properly covered independently without laboratories, should continue according to the present arrangement.
- The faculty members should be encouraged to frequently attend short courses, seminars and workshops which may be arranged locally or internationally by various agencies.

SCHEME OF STUDIES FOR GRADUATE DEGREES

Semester I			Semester II		
Code	**Course Title**	**CR**	**Code**	**Course Title**	**CR**
EE-501	Semiconductor Materials and Technology	3	EE-503	IC Design	3
EE-502	Electronic Systems Design	3	EE-504	Digital Integrated Circuits for Communication	3
EE-5XX	Elective-I	3	EE-5XX	Elective-II	3
	Total	**9**		**Total**	**9**

Semester IV			Semester III		
Code	**Course Title**	**CR**	**Code**	**Course Title**	**CR**
EE-5XX	Elective-III	3	EE-5XX	Elective-IV	3
EE-599A	Thesis *	3	EE-599B	Thesis *	3
	Total	**6**		**Total**	**6**

Total Credit Hours = 30

* The duration of the thesis should be at least two semesters.

Areas of Specialization:

1. Semiconductor Materials, Devices, and Design
2. Electronic Systems Engineering
3. Power Electronics
4. Bio-Electronics

Graduate Elective Courses

Semiconductor Materials, Devices and Design

EE-5XX Solid-State Electronics (3)*
EE-5XX Semiconductor Devices and Technology (3)
EE-5XX Compound Semiconductor Devices (3)
EE-5XX Optoelectronic Devices (3)
EE-5XX Modeling and Simulation of Semiconductor Devices (3)
EE-5XX Semiconductor Material Characterization (3)
EE-5XX Semiconductor Device Reliability (3)
EE-5XX Introduction to MEMS Design and Micromachining (3)
EE-5XX Nanotechnology (3)
EE-5XX Linear Integrated Circuits (3)
EE-5XX Advanced VLSI Design (3)
EE-5XX Fiber Optics and Integrated Optics (3)
EE-5XX Special Topics in Semiconductor Materials and Devices (3)

Electronic Systems Engineering

EE-5XX Advanced Digital Control (3)
EE-5XX Modeling and Simulation of Dynamic Systems (3)
EE-5XX Microprocessor-Based System Design (3)
EE-5XX Advanced FPGA-Based Design (3)
EE-5XX Instrumentation and Systems (3)
EE-5XX Multirate Systems and Filter Banks (3)
EE-5XX Special Topics in Electronic Systems Engineering (3)

Power Electronics

EE-5XX Power Electronic Devices (3)
EE-5XX AC-to-DC and DC-to-AC Converters (3)
EE-5XX Control of DC Machine Drives (3)
EE-5XX Control of AC Machine Drive (3)
EE-5XX Switched-Mode Converter Analysis and Design (3)
EE-5XX Special Topics in Power Electronics (3)

Bio-Electronics

EE-5XX Biomedical Materials and Sensors (3)
EE-5XX Bio-Instrumentation Design (3)
EE-5XX Bio-Electric Signal Analysis and Interpretation (3)
EE-5XX Diagnostic Imaging Systems (3)
EE-5XX Special Topics in Bio-Medical Electronics (3)

* – (3 Credit-hour course)

Details of Graduate Core Courses

EE-501 Semiconductor Materials and Technology 3

Prerequisite: BH-140 Applied Physics
EE-4XX Microelectronic Technology

Objective: Review the theory of solid-state physics and teach the materials and processes used in fabrication of solid-state devices.

Course Outline:

Theory of solid-state physics to give basic information necessary to understand device physics; semiconductor heterojunctions; PN junction operation; BJT operation, forward current, base recombination current, uniform and nonuniform doping, planar BJT structures, limitations of simple analytical BJT models; Schottky-barrier contacts; ohmic contacts; MOS structure, capacitance, MOS electronics, oxide and interface charge; charge coupled devices; basic theory of MOSFET and its parameters, MOSFET design; quantum wires, quantum dots, resonant tunneling diodes, single-electron transistors, computation by single spin; fabrication techniques of semiconductor devices: fundamental principles of "front-end" processes used in the fabrication of devices for silicon integrated circuits including advanced physical models and practical aspects of major processes such as oxidation, diffusion, ion implantation, and epitaxy; issues in modern device scaling.

Recommended Books:

- Donald A. Neamen, “Semiconductor Physics and Devices,” Third Edition, 2003, McGraw-Hill, ISBN: 0072321075.
- James D. Plummer, Michael D. Deal and Peter B. Griffin, “Silicon VLSI Technology: Fundamentals, Practice, and Modeling,” 2001, Prentice Hall, ISBN: 0130850373.
- Betty Lise Anderson and Richard L. Anderson, “Fundamentals of Semiconductor Devices,” First Edition, 2005, McGraw-Hill, ISBN: 0072369779.
- Richard S. Muller and Theodore I. Kamins, “Device Electronics for Integrated Circuits,” Third Edition, 2003, John Wiley & Sons, ISBN: 0471593982.

EE-502 Electronic Systems Design 3

Objective: Teach the methods and tools for the design of analog and digital electronic systems.

Course Outline:

System design based on quantitative performance concepts; design of electronic systems using discrete devices; integrated circuits including analog, digital, and hybrid circuits; linear and nonlinear amplifiers; active filters; signal generators; signal modulators; switched-mode power converters and analog/digital data conversion;

sensors and actuators; combinational logic design; design of microprocessor-based and microcomputer-oriented subsystems; design of continuous and digital control systems using modern analytic and computer design tools.

Recommended Books:

- C. D. Motchenbacher and J. A. Connelly, “Low-Noise Electronic System Design,” 1993, John Wiley & Sons ISBN: 0471577421.
- Kenneth R. Laker and Willy M. C. Sansen, “Design of Analog Integrated Circuits and Systems,” 1994, McGraw-Hill, ISBN: 007036060X.
- Mohamed Rafiquzzaman, “Introduction to Microprocessors and Microcomputer-Based System Design,” Second Edition, 1995, CRC Press, ISBN: 0849344751.
- Steve Heath, “Embedded Systems Design,” Second Edition, 2002, Newnes, ISBN: 0750655461.
- Rob A. Rutenbar, Georges G. E. Gielen and Brian A. Antao, “Computer-Aided Design of Analog Integrated Circuits and Systems,” 2002, Wiley-IEEE Press, ISBN: 047122782X.
- Charles L. Phillips and H. Troy Nagle, “Digital Control System Analysis and Design,” Third Edition, 1995, Prentice Hall, ISBN: 013309832X.

EE-503	IC Design	*3*

Objective: Teach the simulation and design of application-specific integrated circuits.

Course Outline:

Different ASIC design styles and technologies, design flow, full-custom/semi-custom circuit techniques, layout of full-custom CMOS ICs, simulation (different types and levels), design-for-test, use of full-custom IC design tools.

Recommended Books:

- Jan M. Rabaey**,** Anantha Chandrakasan and Borivoje Nikolic “Digital Integrated Circuits: A Design Perspective,” Second Edition, 2003, Prentice Hall, ISBN: 0130909963.
- Neil H. E. Weste and David Harris, “CMOS VLSI Design,” Third Edition, 2005, Addison Wesley, ISBN: 0321149017.
- Michael John Sebastian Smith, “Application Specific Integrated Circuits,” 1997, Addison Wesley, ISBN: 0201500221.

EE-504	Digital Integrated Circuits for Communication	*3*

Prerequisite: EE-503 IC Design

Objective: Cover the static and dynamic latches and registers, memories, drivers, and buffers. Teach the considerations, such as

speed and power dissipation, reduced supply voltages, and pipelining, in the design and applications of digital integrated circuits.

Course Outline:

Dynamic CMOS design; dynamic logic: Basic principles, speed and power dissipation of dynamic logic, issues in dynamic design, cascading dynamic gates. Designing logic for reduced supply voltages; static latches and registers; bistability principle; multiplexer-based latches; low-voltage static latches; static SR Flip-Flops – writing data by pure force; dynamic latches and registers; dynamic transmission; C2MOS – clock-skew insensitive approach; true single-phase clocked register (TSPCR); alternative register styles; pulse registers, sense-amplifier based registers; pipelining: an approach to optimize sequential circuits; latch- vs. register-based pipelines; NORA-CMOS – logic style for pipelined structures; non-bistable sequential circuits; Schmitt trigger; monostable sequential circuits; astable circuits; memory core; read-only memories; nonvolatile read-write memories; read-write memories (RAM); contents-addressable or associative memory (CAM); memory peripheral circuitry; address decoders; sense amplifiers; voltage references; drivers/buffers; timing and control; memory reliability and yield; signal-to-noise ratio; memory yield; power dissipation in memories.

Recommended Books:

- Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, “Digital Integrated Circuits,” Second Edition, 2002, Prentice Hall, ISBN: 0130909963.
- Mohab Anis and Mohamed Elmasry, “Multi-Threshold CMOS Digital Circuits: Managing Leakage Power,” 2003, Springer, ISBN: 1402075294.
- John E. Ayers, “Digital Integrated Circuits: Analysis and Design,” 2003, CRC Press, ISBN: 084931951X.

Details of Graduate Elective Courses

Semiconductor Materials, Devices and Design

EE-5XX	Solid-State Electronics	*3*

Objective: Teach the fundamentals of solid-state physics including quantum mechanics, Schrodinger representation of quantum effects, effective mass theorem, Boltzman transport theory, and semiconductor devices.

Course Outline:

Atomic physics, lattices, quantum mechanics, phonons, scattering, study of the electron and hole processes in solids, solutions to Schrodinger representation of quantum effects, perturbation techniques, simple band structure, effective mass theorem, derivation and application of Boltzman transport theory, electrical and thermal conductivities of metals and semiconductors, Hall effect and thermal effects with applications to electronic devices, properties of semiconductors and theories underlying the characteristics of semiconductor devices.

Recommended Books:

- Charles Kittel, "Introduction to Solid State Physics," Eighth Edition, 2004, John Wiley & Sons, ISBN: 0471680575.
- Michael Shur, "Physics of Semiconductor Devices," First Edition, 1990, Prentice Hall, ISBN: 0136664962.
- Ben G. Streetman and Sanjay Banerjee, "Solid State Electronic Devices," Sixth Edition, 2006, Prentice Hall, ISBN: 013149726X.

EE-5XX	Semiconductor Devices and Technology	*3*

Prerequisite: EE-5XX Solid-State Electronics

Objective: Teach the physics, principles of operation, fabrication, and packaging of semiconductor devices.

Course Outline:

Energy bands and carrier concentrations in semiconductors; motion of charge carriers in solids; *p-n* junction; junction transistor; light emitting diode; photodiode; junction lasers; MOSFETs, MESFETs, factors limiting the performance of each type of device along with their optimization trends and on-going search for novel device structures; fabrication technology for microelectronic devices: crystal growth, wafer fabrication and characterization, mask fabrication, epitaxy, lithography, etching, diffusion, CVD, ion implantation, packaging.

Recommended Books:

- Simon M. Sze and Kwok K. Ng, "Physics of Semiconductor Devices," Third Edition, 2006, John Wiley & Sons, ISBN: 0471143235.
- Ben G. Streetman and Sanjay Banerjee, "Solid State Electronic

Devices," Sixth Edition, 2006, Prentice Hall, ISBN: 013149726X.

EE-5XX Compound Semiconductor Devices 3

Prerequisite: EE-5XX Solid-State Electronics

Objective: Teach the physics, electronic properties, and processing of compound semiconductors (III-V and II-VI).

Course Outline:

Direct and indirect bandgap semiconductors; physics of compound semiconductors (III-V and II-VI); electronic properties and their importance to compound semiconductors; optical processes in compound semiconductors; importance of III-V and II-VI devices in photonics; optoelectronics devices and integrated circuits; preparation and processing of compound semiconductors; techniques for preparation of *p*- and *n*-type materials of compound semiconductors; theory of heterojunctions, quantum structures and pseudomorphic strained layers; metal-semiconductor field effect transistors (MESFETs); heterojunction field-effect transistors (HFETs) and bipolar transistors (HBTs); photodiodes, quantum well heterostructure lasers, and other optoelectronic devices.

Recommended Books:

- Paul H. Holloway and Gary E. McGuire, "Handbook of Compound Semiconductors - Growth, Processing, Characterization, and Devices," 1995, Noyes Publications, ISBN: 0815513747.
- Joachim Piprek, "Semiconductor Optoelectronic Devices: Introduction to Physics and Simulation," 2003, Academic Press, ISBN: 0125571909.

EE-5XX Optoelectronic Devices 3

Objective: Teach optoelectronic devices including lasers, optical detectors, optical fiber couplers, optical modulators, and optical amplifiers.

Course Outline:

Fundamentals of semiconductor devices; *p-n* junctions; hetrojunction and double hetrojunction; basics of laser physics: spontaneous and stimulated emission, Einstein relation, population inversion, optical pumping, light amplification, resonators and modes; light sources; light emitting diodes (LEDs); laser diodes; different types of semiconductor laser sources; optical detectors: *p-n* junction diodes, PIN diodes, avalanche photodiodes, optical switches, optical fiber couplers; noise considerations and performance parameters; optical modulators, for example, electro-optical and acousto-optic modulators; optical amplifiers; GRI lenses.

Recommended Books:

- Bhattacharya "Semiconductors Optoelectronic Devices," Second Edition, Pearson Education India, ISBN 817758166X.

- Gerd Keiser, “Optical Fiber Communications,” Third Edition, 2000, McGraw-Hill, ISBN: 0072360763.
- John M. Senior, “Optical Fiber Communications: Principles and Practice”, 2nd Edition, 1992, Prentice Hall, ISBN: 0136354262.

EE-5XX	Modeling and Simulation of Semiconductor Devices	*3*

Prerequisite: EE-5XX Solid-State Electronics

Objective: Review semiconductor physics and basic semiconductor equations, and teach the development of models to simulate various semiconductor devices.

Course Outline:

Review of semiconductor physics; basic semiconductor equations; numerical methods applied for scaling of variables and parameters: Newton-Raphson method of solving nonlinear algebraic equations, iterative and other methods; error estimation; Monte Carlo simulation: Boltzmann transport equation; electron motion in the momentum space; scattering processes; mean velocity; device modeling and simulation of *p*-*n* junctions: potential barriers, static properties, reverse-biased junctions, avalanche and zener breakdowns, Shockley-Hall-Read Model, *I*-*V* characteristics, charge storage and transients, numerical simulation of *p*-*n* junctions; device modeling and simulation of BJT: Early effect, emitter biases, base transit time-charge control model, simulation of BJTs; device modeling and simulation of MOS: model of charges in gate oxides, modeling of charges in accumulations, depletion, and inversion conditions, capacitance, threshold voltage adjustment; device modeling and simulation of MOSFET: basic theories and models, MOSFET parameters, short and narrow channel effects, hot carriers, simulation of MOSFET characteristics, adjustment of threshold voltage, model design of MOSFET; modeling and simulation of CMOS characteristics, CMOS design; HBT: bandgap engineering, material parameters, modeling of HBT characteristics.

Recommended Books:

- Richard S. Muller and Theodore I. Kamins, “Device Electronics for Integrated Circuits,” Third Edition, 2003, John Wiley & Sons, ISBN: 0471593982.
- Christopher M. Snowden, “Introduction to Semiconductor Device Modelling,” 1987, World Scientific Publishing Company, ISBN: 9971501422.

EE-5XX	Semiconductor Material Characterization	*3*

Objective: Teach the techniques for structural, optical, and other characterization of semiconductor materials.

Course Outline:

Techniques for structural characterization of semiconductor materials, x-ray scattering, low-energy electron diffraction (LEED), electron microscopy, scanning electron microscope, scanning probe microscope, techniques for optical and other characterization of semiconductor materials, photoluminescence, x-ray photoelectron scattering (XPS), Auger electron scattering (AES), secondary ion mass scattering (SIHS).

Lab Outline:

Measurement and characterization based on any above-mentioned techniques.

Recommended Book:

- Dieter K. Schroder, "Semiconductor Material and Device Characterization," 1998, John Wiley & Sons, ISBN: 0071402144.

EE-5XX Semiconductor Device Reliability *3*

Objective: Teach the concepts of reliability and failure physics, degradation mechanisms and reliability of semiconductor devices, accelerated testing, and failure analysis.

Course Outline:

Overview of semiconductor devices and technology; overview of reliability and failure physics; defects and contaminants, and their effect on yield; mathematics of failure and analysis; degradation mechanisms in semiconductor devices; degradation of contacts and package interconnections; compound semiconductor reliability for microwave field effect transistors and heterojunction bipolar transistors; latch-up and IC degradation; reliability of optoelectronic components (lasers, photodetectors, optical interconnects); power device reliability; accelerated testing; failure analysis and characterization techniques.

Recommended Books:

- Milton Ohring, "Reliability and Failure of Electronic Materials and Devices," 1998, Academic Press, ISBN: 0125249853.

EE-5XX Introduction to MEMS Design and Micromachining *3*

Objective: Teach the principles of operation, design, modeling, micromachining, and fabrication of MEMS devices.

Course Outline:

MEMS devices: MEMS operating principle (electrostatic, piezoresistive, thermal), applications, accelerometers/combdrive, RF switch, micromirror. Design: Scaling issues, system-level design (behavioral modeling) using SPICE, 2D layout design (L-Edit Layout tool, design rule checking, design verification), 3D modeling with process emulation, physical level simulation and analysis (Finite

Element Analysis) using ANSYS. Micromachining (micro-fabrication) technologies: Micromachining techniques (deposit, etch, photolithography), CMOS compatible bulk micromachining, surface micromachining.

A surface micromachining technology PolyMUMPs will be studied with description of technology file development in L-Edit layout tool. Various MEMS devices will be fabricated in PolyMUMPs process.

Recommended Books:

- Chang Liu, "Foundation of MEMS," First Edition, 2006, Prentice Hall, ISBN: 0131472860.
- Stephen D. Senturia, "Microsystem Design," First Edition, 2000, Kluwer Academic Publishers, ISBN: 0792372468.
- Marc J. Madou, "Fundamentals of Microfabrication: The Science of Miniaturization," Second Edition, 2002, CRC Press, ISBN: 0849308267.
- Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture," First Edition, 2001, McGraw-Hill, ISBN: 0072393912.
- M. Elwenspoek and H. Jansen, "Silicon Micromachining," 1998, Cambridge University Press, ISBN: 052159054X.
- Nadim Maluf and Kirt Williams, "An introduction to Microelectromechanical Systems Engineering," 2004, Artech House Publishers, ISBN: 1580535909.

EE-5XX	Nanotechnology	*3 + 0*

Prerequisite: Instructor consent.

Objective: Introduce nanotechnology and teach the properties of nanoparticles, carbon nanostructures, bulk nanostructured materials, quantum nanostructures, self-assembly and catalysis, and nanomachines and nanodevices.

Course Outline:

Introduction to the physics of solid state: Structure, energy bands, localized particles. Methods of measuring properties: Structure, microscopy, spectroscopy. Properties of individual nanoparticles: Metal nanoclusters, semiconducting nanoparticles, rare gas and molecular clusters. Carbon nanostructures: Carbon molecules, carbon clusters, carbon nanotubes, applications of carbon nanotubes. Bulk nanostructured materials: Solid disordered structures, nanostructured crystals. Nanostructured ferromagnetism. Quantum wells, wires and dots: Preparation of quantum nanostructures, size and dimensionality effects, excitons, single-electron tunneling, superconductivity, applications. Self-assembly and catalysis. Organic compounds and polymers: Forming and characterizing polymers, nanocrystals, polymers, supramolecular structures. Nanomachines and nanodevices: Microelectromechanical systems (MEMS), nanoelectromechanical systems (NEMS), molecular and

supramolecular switches.

Recommended Books:

- Charles P. Poole Jr. and Frank J. Owens, “Introduction to Nanotechnology,” 2003, John Wiley & Sons, ISBN: 0471079359.
- Massimiliano Di Ventra, Stephane Evoy and James R. Heflin Jr. (Editors), “Introduction to Nanoscale Science and Technology,” 2004, Kluwer Academic Publishers, ISBN: 1402077203.
- Mark A. Reed and Takhee Lee (Editors), “Molecular Nanoelectronics,” 2003, American Scientific Publishers, ISBN: 1588830063.

EE-5XX	Linear Integrated Circuits	*3*

Objective: Teach the design of linear integrated circuits including the design of amplifiers, operational amplifiers, current mirrors, output stages, reference circuits, and DC power supplies for linear integrated circuits.

Course Outline:

Design of linear integrated circuits applying modern MOS and BJT integrated circuit technologies: Single-stage amplifiers, current-mirror DC bias and active load circuits, stability and frequency compensation of single-stage and two-stage operational amplifiers, output stages, current and voltage reference circuits. Introduction to linear integrated circuit devices: IC operational amplifier, inverting and non-inverting operational amplifier configurations. Dealing with practical operational amplifiers: Instrumentation amplifiers, isolation amplifiers, non-operational IC linear amplifiers. High frequency, VHF, UHF and microwave linear IC devices, IC waveform generators and wave-shaping circuits, DC power supplies for linear integrated circuits.

Recommended Books:

- Behzad Razavi, “Design of Analog CMOS Integrated Circuits”, First Edition, 2001, McGraw-Hill, ISBN: 0072380322.
- Paul R. Gray, Paul J. Hurst, Stephen H. Lewis and Robert G. Meyer, “Analysis and Design of Analog Integrated Circuits”, Fourth Edition, 2001, John Wiley & Sons, ISBN: 0471321680.
- Joseph J. Carr and Joe Carr, “Linear Integrated Circuits,” 1996, Newnes, ISBN: 0750625910.

EE-5XX	Advanced VLSI Design	*3*

Objective: Teach VLSI synthesis and design tools, languages for VLSI synthesis, algorithm simulation and code generation, and design tools for application specific instruction processors.

Course Outline:

Design methodology for ASIC and FPGA implementations; high-level VLSI synthesis and design tools including Mentor Graphics; FPGA

hardware structures and fabrics; languages for VLSI synthesis including VHDL; high-level DSP algorithm simulation and code (VHDL) generation using Xilinx StateCAD, LabVIEW FPGA, and ModelSim; design and analysis of algorithm-specific VLSI processor architectures; implementation of pipelined and systolic processor structure; techniques for mapping numerical algorithms onto custom processor arrays including application specific instruction processors (ASIPs); design tools for ASIPs including transport triggered architecture; high-level design frameworks for systems containing custom and general-purpose units.

Recommended Books:

- William J. Dally and John W. Poulton, "Digital Systems Engineering," 1998, Cambridge University Press, ISBN: 0521592925.
- Behzad Razavi, "Design of Analog CMOS Integrated Circuits," First Edition, 2001, McGraw-Hill, ISBN: 0072380322.
- Shih-Chii Liu, Jörg Kramer, Giacomo Indiveri, Tobias Delbrück and Rodney Douglas, "Analog VLSI: Circuits and Principles," 2002, MIT Press, ISBN: 0262122553.
- Wayne Wolf, "FPGA-Based System Design," First Edition, 2004, Prentice Hall, ISBN: ISBN: 0131424610.
- Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits," Second Edition, 2002, Prentice Hall, ISBN: 0130909963.

EE-5XX Fiber Optics and Integrated Optics *3*

Objective: Teach optical fiber waveguides, optical propagation, losses in optical propagation, optical fiber parameter measurement, and fiber optic communication systems.

Course Outline:

Optical fiber waveguide, ray theory for transmission, electromagnetic mode theory for optical propagation, cylindrical fiber, single mode fiber transmission characteristics of optical fibers, attenuation, material absorption losses in silicon glass fibers, scattering losses, overall fiber dispersion, optical fiber parameter measurement, optical time-domain reflectometry, fiber optic communication systems, optical fiber sensor technology, modes of optical fiber and coupled mode analysis of passive optical fiber devices, pulse propagation in optical fibers and its application to communication systems.

Recommended Books:

- John M. Senior, "Optical Fiber Communications: Principles and Practice", 2nd Edition, 1992, Prentice Hall, ISBN: 0136354262.
- Gerd Keiser, "Optical Fiber Communications," Third Edition, 2000, McGraw-Hill, ISBN: 0072360763.
- Harold Kolimbiris, "Fiber Optics Communications," First Edition,

2004, Prentice Hall, ISBN: 0130158836.

- Djafar Mynbaev and Lowell Scheiner, “Fiber-Optic Communications Technology,” First Edition, 2001, Prentice Hall, ISBN: 0139620699.

Electronic Systems Engineering

EE-5XX	Advanced Digital Control	3

Objective: Teach z transform theory, design of digital control systems, stability analysis, microprocessor implementation of digital filters and controllers, computer control of feedback systems, optimal control, fuzzy logic, and robust control.

Course Outline:

Overview of linear discrete dynamic systems and z-transform theory, design of digital filters, z-plane analysis and design of digital control systems using conventional techniques and state-space methods, stability analysis techniques, parameterization of stable digital control systems, compensator design, digital controller design, quadratic optimal control, pole-assignment design and state estimation, microprocessor implementation of digital filters and controllers, sample-data systems, sampling and reconstruction, quantization effects, computer control of feedback systems, performance of digital control system, overview to multivariable and optimal control, system identification, fuzzy logic, adaptive filtering, non-linear systems, robust control.

Recommended Books:

- Charles L. Phillips and H. Troy Nagle, “Digital Control System Analysis and Design,” Third Edition, 1995, Prentice Hall, ISBN: 013309832X.
- Dogan Ibrahim, “Microcontroller Based Applied Digital Control,” 2006, John Wiley & Sons, ISBN: 0470863358.
- Katsuhiko Ogata, “Discrete-Time Control Systems,” Second Edition, 1995, Prentice Hall, ISBN: 0130342815.
- Gene F. Franklin, Michael L. Workman and Dave Powell, “Digital Control of Dynamic Systems,” Third Edition, 1997, Addison Wesley, ISBN: 0201820544.
- Benjamin C. Kuo, “Digital Control Systems,” Second Edition, 1995, Oxford University Press, ISBN: 0195120647.

EE-5XX	Modeling and Simulation of Dynamic Systems	3

Objective: Teach the modeling and simulation of various engineering systems to study the dynamic characteristics of systems and enable the students to design systems.

Course Outline:

Overview of dynamic systems: Introduction to modeling and simulation, models for dynamic systems and system similarity. Modeling of engineering systems: Mechanical systems, electrical systems, fluid systems, thermal systems, mixed discipline systems. System dynamic response analysis: Frequency response, time

response and digital simulation. Engineering applications: System design and selection of components.

Recommended Books:

- Finn Haugen, "Dynamic Systems: Modeling, Analysis and Simulation," 2004, Tapir Academic Press, ISBN: 8251919266.
- Robert H. Woods and Kent L. Lawrence, "Modeling and Simulation of Dynamic Systems," 1997, Prentice Hall, ISBN: 0133373797.

EE-5XX Microprocessor-Based System Design *3*

Objective: Teach the architecture, programming, interfacing, and applications of microprocessors.

Course Outline:

Architecture, instruction cycle, registers and stacks, external interface, register architecture, external interface, addressing modes, branching and conditions, stack commands, subroutines, port I/O, interrupts, internal operation of processor, register transfer logic, instruction formats, microcode, timing diagrams, design techniques such as pipelining, other microprocessors, addressing modes, instruction sets, timing , high-level languages: programming in C, design of systems, memory, static/dynamic RAM, technology and timing, ROM, PROMs, EPROMs, PLAs, DMC chips address decoding, EDAC I/O, parallel and serial I/O, DMA, interrupts and interrupt control circuits, microcomputer buses, system bus, bus interface and arbitration circuits bus standards, peripherals, keyboards, CRT controllers, printers, secondary memory, A/D and D/A conversions, data acquisition systems using microprocessors.

Recommended Books:

- David J. Comer, "Microprocessor-based System Design," 1996, Oxford University Press, ISBN: 0030637813.
- Muhammad Ali Mazidi and Janice Gillispie-Mazidi, "80X86 IBM PC and Compatible Computers: Assembly Language, Design, and Interfacing Volumes I & II," Fourth Edition, 2003, Prentice Hall, ISBN: 013061775X.

EE-5XX Advanced FPGA-Based System Design *3*

Prerequisite: EE-4XX FPGA-Based System Design

Objective: Introduce the students to logic synthesis and FPGA implementation tools and methods.

Course Outline:

This course introduces logic synthesis, implementation, and SoC design concepts. The course is project oriented where students will take designs from concept to Verilog HDL description to verification using simulation and synthesis, and finally to programmable device

implementation on an FPGA development board.

During the first part of the course, students will implement a few projects, each more complex than the last, culminating in a complete SoC design incorporating an 8-bit microprocessor and peripherals. The first project, a simple FSM, serves to introduce students to logic synthesis and FPGA implementation tools and methods, and how to use the input/outputs devices (such as buttons and LEDs) on the FPGA development board. The second project introduces SoC concepts such as on-chip processor, memory and peripheral interfacing, and hardware-software trade-offs. The third project adds a graphics sub-system to the SoC enabling students to display their design results on a CRT monitor. This lab sequence goes in step with lectures on programmable chip architectures, logic synthesis, SoC concepts, and the Verilog synthesizable subset, including design examples.

During the final part of the course, after mid-semester examination, the students will work in teams of two to complete an advanced FPGA design project of their choice. The final project will be more complex than any of the three previously assigned projects. There will be no scheduled lectures during this portion of the course, but the instructors are required to be available to guide the students.

Recommended Books:

- Wayne Wolf, "FPGA-Based System Design," 2004, Prentice Hall, ISBN: 0131424610.
- Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis," Second Edition, 2003, Prentice Hall, ISBN: 0130449113.
- Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL," First Edition, 2003, Prentice Hall, ISBN: 0130891614.

EE-5XX Instrumentation and Systems *3*

Objective: Teach the methods for the measurement and control of systems including numeric control systems, programmable controllers, and distributed systems.

Course Outline:

Study of automatic testing of electronic devices, physical properties and their measurement, different types of field instrumentation, industrial electronic circuit applications, interfacing process variables, motor control and servo systems, servo amplifiers and drives, numeric control systems, programmable controllers and distributed control systems.

Recommended Books:

- Chester L. Nachtigal, "Instrumentation and Control: Fundamentals and Applications," 1990, John Wiley & Sons, ISBN: 0471880450.
- Mike Tooley, "PC Based Instrumentation and Control," Third

Edition, 2005, Newnes, ISBN: 0750647167.

- W. Bolton, “Programmable Logic Controllers,” Third Edition, 2003, Newnes, ISBN: 0750659866.
- Thomas E. Kissell, “Industrial Electronics: Applications for Programmable Controllers, Instrumentation and Process Control, and Electrical Machines and Motor Controls,” Third Edition, 2003, Prentice Hall, ISBN: 0130602418.

EE-5XX	Multirate Systems and Filter Banks	*3*

Objective: Teach multirate signal processing, multirate filter banks, wavelet transforms, and applications of multirate filter banks.

Course Outline:

Review of discrete-time systems and digital filters, multirate signal processing, multirate operations, interconnection of building blocks in multirate systems, multirate filter banks and perfect reconstruction systems, polyphase representation, structures for decimation and interpolation filters, paraunitary filter banks, wavelet transforms and relation to multirate filter banks, applications of multirate systems, maximally decimated filter banks, filters of QMF type, Johnston's filters.

Recommended Books:

- P. P. Vaidyanathan, “Multirate Systems and Filter Banks,” 1993, Prentice Hall, ISBN: 0136057187.
- N. J. Fliege, “Multirate Digital Signal Processing: Multirate Systems - Filter Banks - Wavelets,” 1999, John Wiley & Sons, ISBN: 0471492043.

Power Electronics

EE-5XX Power Electronic Devices 3

Objective: Teach the structures, principles of operation, characteristics, and cooling of semiconductor power devices.

Course Outline:

Physical construction, operation and characteristics of power diode, power diode static and dynamic modeling, diode behavior with resistive and inductive loads, fast recovery diodes, physical construction, operation and characteristics of power thyristor, SCR static and dynamic modeling, GTO construction and operation, GTO static and dynamic characteristics, GTO modeling, physical construction and operation of power BJT, static and dynamic characteristics of power BJT, construction and operation of MOSFET, static and dynamic characteristics of IGBT, IGBT modeling, thermal calculations and heat sink designing.

Recommended Books:

- John G. Kassakian, Martin F. Schlecht and George C. Verghese, “Principle of Power Electronics,” First Edition, 1991, Prentice Hall, ISBN: 0201096897.
- B. W. Williams, “Power Electronics: Devices, Drivers, Applications, and Passive Components,” Second Edition, 1992, McGraw-Hill, ISBN: 0070704392.

EE-5XX AC-to-DC and DC-to-AC Converters 3

Objective: Teach the analysis and design of various types of rectifier and inverter circuits.

Course Outline:

Overview of converters; single- and three-phase rectifier and inverter circuits; voltage- and current-source inverters; series and parallel connections of multi-step converters; effect of overlap and output voltage; freewheeling current; three-pulse, six-pulse, twelve-pulse and twenty-four-pulse circuits; load voltage and current harmonics; displacement factor and power factor; controlled converters; full-cycle and half-cycle control; PWM converters; unity power factor and leading power factor control; drive circuits for BJTs, IGBTs, MOSFETs, GTOs and thyristors; cycloconverters.

Recommended Books:

- Cyril W. Lander, “Power Electronics,” Third Edition, 1993, McGraw-Hill UK, ISBN: 0077077148.
- John G. Kassakian, Martin F. Schlecht and George C. Verghese, “Principle of Power Electronics,” First Edition, 1991, Prentice Hall, ISBN: 0201096897.

EE-5XX	Control of DC Machine Drives	*3*

Objective: Teach the construction, principles of operation, characteristics, and methods for electronic control of different types of DC electrical machines.

Course Outline:

DC machine fundamentals, torque and speed characteristics of DC machine, DC motor drive, four-quadrant operation, speed control of DC motor, field weakening, traction drive, dynamic modeling of DC motor and drive, PID control, stability of DC motor control, phase-locked loop control of DC motor, brushless motor fundamentals, types of brushless DC motors, control of brushless DC motors, construction and operation of SRM, control of switched reluctance motor.

Recommended Books:

- P. C. Sen, “Thyristor DC Drives,” 1991, Krieger Publication Co, ISBN: 0894646087.
- Bimal K. Bose, “Modern Power Electronics and AC Drives,” 2001, Prentice Hall, ISBN: 0130167436.

EE-5XX	Control of AC Machine Drives	*3*

Category:

Objective: Teach the construction, principles of operation, characteristics, and methods for electronic control of different types of AC electrical machines.

Course Outline:

AC machine fundamentals, torque production in induction motors, equivalent circuit analysis, variable-voltage operation, variable-speed operation, harmonic effect, dynamic modeling of inverter-machine, slip power control, scalar methods, vector control methods, adaptive control.

Recommended Books:

- Bimal K. Bose, “Modern Power Electronics and AC Drives,” 2001, Prentice Hall, ISBN: 0130167436.
- Peter Vas, “Vector Control of AC Machines,” 1990, Oxford University Press, ISBN: 0198593708.

EE-5XX	Switched-Mode Converter Analysis and Design	*3*

Objective: Teach the analysis and design of switched-mode converters including the selection of topology, semiconductor devices, capacitors, magnetic components, snubber circuits, feedback loop design, cooling, circuit layout, and EMI.

Course Outline:

Principles of electronic power conversion in switched-mode converters, applications of converters, fundamental switching regulators: buck, boost, push-pull, forward and flyback converter topologies; half-bridge and full-bridge converter topologies; current-mode and current-fed topologies; analysis and design of PWM converters including the selection of semiconductor devices and capacitors, magnetic and circuit designs, switching losses and snubber design, design of control circuits, design of feedback loop, feedback loop stabilization, thermal management, measurement of performance, and fundamentals of circuit layout and EMI.

Recommended Books:

- Robert W. Erickson and Dragan Maksimovic, “Fundamentals of Power Electronics,” Second Edition, 2001, Kluwer Academic Publishers, ISBN 0792372700.
- Abraham I. Pressman, “Switching Power Supply Design”, Second Edition, 1998, McGraw-Hill, ISBN: 0070522367.
- Martin Brown, “Practical Switching Power Supply,” 1990, Academic Press, ISBN: 0121370305.

Bio-Electronics

EE-5XX	Biomedical Materials and Sensors	3

Objective: Teach biomedical materials, selection and design of biomedical materials for implants, and design and analysis of biomedical sensing and transducing components.

Course Outline:

Molecular structure-property relationships in biomaterials; focus on polymers, metals, ceramics, composites, and biodegradable materials; selection, design and function of biomedical materials for implants: bioelectrical and biomechanical concepts; biomedical imaging for flow properties of blood and material-tissue interaction; sensors and their characteristics; design of artificial biomaterials for biosensors; principles of biologically-based sensing elements and interfacing techniques; design and analysis methods of biosensing and transducing components.

Recommended Books:

- Gabor Harsanyi, "Sensors in Biomedical Applications: Fundamentals, Technology and Applications," 2000, CRC Press, ISBN: 1566768853.
- Roderic S. Lake and Joon B. Park, "Biomaterials: An introduction," Second Edition, 1992, Kluwer Academic/Plenum Publishers, ISBN: 0306439921.
- P. I. Haris and D. Chapman, "New Biomedical Materials," 1998, IOS Press, ISBN: 905199365X.
- Joon B. Park and Joseph D. Bronzino, "Biomaterials: Principles and Applications," 2002, CRC Press, ISBN: 0849314917.
- John G. Webster, "Bioinstrumentation," 2003, John Wiley & Sons, ISBN: 0471452572.

EE-5XX	Bio-Instrumentation Design	3

Prerequisite: EE-4XX Biomedical Instrumentation

Objective: Teach methods for the measurement and analysis of biological systems including cardiopulmonary support, blood pressure and sound measurements, blood flow and volume measurements, respiratory system measurements, biotelemetry, and microprocessor-based biomedical instrumentation.

Course Outline:

Theory of measurement and analysis of biological systems; characteristics of bioelectric signals; recording electrodes; biopotential amplifiers; basic sensors; chemical, pressure, sound, and flow transducers; electrophysiology and electromyography, and interpretation; instrumentation; cardiopulmonary support; blood pressure and sound measurement; blood flow and volume measurement; respiratory system measurements; biotelemetry:

transmission and reception aspects of biological signals; aspects of patient care monitoring; electronic circuit design and construction; analog/digital signal acquisition and processing; microprocessor-based biomedical instrumentation; basic principles of hardware and software designs for interfacing biomedical sensors to microprocessors; signal transduction and transfer functions; measurement principles; biological signals: temperature, displacement and force; flow measurements; blood volume; bio-potential: ECG, EMG, EEG; bio-potential electrode; spectroscopic methods for analysis of molecule in biomedicine; oxygenation and pulse oximeter; microscopy; data reduction; surface analysis; fluorescence measurements; single-molecule detection.

Recommended Books:

- R. S. Khandpur, "Biomedical Instrumentation: Technology and Applications," First Edition, 2005, McGraw-Hill, ISBN: 0071447849.
- John G. Webster, "Medical Instrumentation: Application and Design," Third Edition, 1997, John Wiley & Sons, ISBN: 0471153680.
- L. A. Geddes and L. E. Baker, "Principles of Applied Biomedical Instrumentation," Third Edition, 1989, John Wiley & Sons, ISBN: 0471608998.

EE-5XX	Bio-Electric Signal Analysis and Interpretation	*3*

Prerequisite: EE-311 Signal Processing

Objective: Teach bio-electric signal processing and analysis, biomedical signal characterization in time and frequency domain, short-time Fourier transform, chaotic models, and chaotic time series analysis.

Course Outline:

Theoretical concepts and experimental approaches used to characterize electric phenomena in live cells and tissues; excitable membrane; action potential generation; cable theory; equivalent dipoles and volume conductor fields; introduction to bio-electric signal processing and analysis; fundamental techniques to analyze and process signals that originate from biological sources such as ECGs, EMGs, EEGs, blood pressure signals; physiological knowledge with the information useful for physiologic investigation, medical diagnosis and processing; biomedical signal characterization in time and frequency domain; deterministic and stochastic signal analysis methods; short-time Fourier transform; spectrogram; wavelet signal decomposition; characterization of signal dynamics: chaotic, stochastic, fractal (self similar); introduction to simple chaotic models; chaotic time series analysis techniques based on delayed coordinate embedding; concept and measures of signal complexity; statistical analysis techniques; probability density functions; moments; concept

of stochastic process and nonstationarity; linear/nonlinear systems identification and modeling; Volterra and Wiener series.

Recommended Books:

- Eugene N. Bruce, “Biomedical Signal Processing and Signal Modeling,” 2001, John Wiley & Sons, ISBN: 0471345407.
- D. C. Reddy, “Biomedical Signal Processing: Principles and Techniques,” 2005, Tata McGraw-Hill, ISBN: 0070583889.
- Isak Gath and Gideon F. Inbar, “Advances in Processing and Pattern Analysis of Biological Signals,” 1996, Springer, ISBN: 0306452154.
- Metin Akay, “Detection and Estimation Methods for Biomedical Signals,” 1996, Academic Press, ISBN: 0120471434.
- Metin Akay, “Time Frequency and Wavelets in Biomedical Signal Processing,” 1998, IEEE Press, ISBN: 0780311477.

EE-5XX	Diagnostic Imaging Systems	*3*

Objective: Teach medical imaging techniques and their applications, concepts and instrumentation of modern medical imaging modalities, and recent advances in digital diagnostic imaging systems.

Course Outline:

Introduction to physical and mathematical bases of medical imaging techniques and their applications; underlying concepts and instrumentation of modern medical imaging modalities; design and operation of diagnostic imaging systems including fluoroscopy, digital subtraction angiography, mammography, computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI), computed radiography, ultrasound; recent advances in digital diagnostic imaging systems including digital subtraction angiography (DSA) methods of producing three-dimensional images.

Recommended Books:

- Jerry L. Prince and Jonathan Links, “Medical Imaging Signals and Systems,” First Edition, 2005, Prentice Hall, ISBN: 0130653535.
- Macovski, “Medical Imaging Systems,” First Edition, 1983, Prentice Hall, ISBN: 0135726859.
- Z. H. Cho, Joie P. Jones and Manbir Singh, “Foundations of Medical Imaging,” 1993, John Wiley & Sons, ISBN: 0471545732.
- Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing,” Second Edition, 2002, Prentice Hall, ISBN: 0201180758.