SHARIF UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF
ELECTRICAL ENGINEERING

Catalogue
2021

In the Name of God

Contents

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Introduction

General Information

The standard of living in modern societies is highly indebted to the revolutions brought about by advances in electrical engineering since the 19th century. Generation and distribution of electrical energy, development of electric light, invention of telegraph, telephone, radio, and television; and emergence of the modern computers followed by rapid development of mobile communication systems have radically transformed the daily lives, commerce, and culture of modern human beings. It is nowadays unthinkable to try to meet the challenges faced by the humanity -whether in energy production, environment, or health- without electrical engineering.

The diverse spectrum of applications and problems addressed by electrical engineers makes it impossible to give an all-encompassing definition of their field. Traditionally, electrical engineering has been concerned with the development of devices, circuits, and systems based on the electric charge and its motion. In recent decades, however, a paradigm shift has taken place towards more abstract disciplines. Established fields, such as power engineering, electro magnetics, and electronics are nowadays complemented by information theory, signal processing, and control engineering, as their younger brethren.

The Department of Electrical Engineering of Sharif University of Technology (SUT) was founded in 1967, one year after the establishment of Sharif (then Arya-Mehr) University of Technology, in order to address the technical needs of the Iranian industry. While initially offering an undergraduate program with emphasis on education, the EE department has since evolved into country's top electrical engineering institute with international-level research and constant influx of the best students at both the undergraduate and graduate levels. Today, the EE department hosts more than 800 undergraduate students, 550 graduate students (both MSc and PhD), more than 70 professors.

Admission to the EE department of SUT is very competitive: only those students with highest rankings in annually-held national university entrance exam are allowed to enroll in the undergraduate program. A high percentage of graduates of this department continue their studies at the MSc and PhD levels both inside the country and abroad. Sharif's EE department is well known for its many notable alumni in the academic world and the industry, both inside and outside the country.

Research activities in the EE department cover diverse areas in Communications, Electronics, Microwaves and Photonics, Electric Power Engineering, Control & Dynamical Systems, Digital Systems, and Bio-Electric Engineering. The EE department accommodates 30 research laboratories and two national centers of excellence. Overall, it is the mission of the department to encourage and support young researchers to carry out state of the art research, and use its outcome to address the needs of the Iranian industry.

Education

Undergraduate program

The 4-year undergraduate program provides a broad foundation in electrical engineering through combined classroom and laboratory work and prepares the students for their professional career, as well as for further study at the graduate level. During the first and part of the second year, students take courses in basic sciences and general engineering. Emphasis is placed on mathematics and physics, as well as programming and introductory electric circuits. The remainder of the second year, and the 1st part of the third year are dedicated to intermediate-level courses in electrical engineering. In the 2nd part of the third year and the fourth year, students will take courses from one of the areas of Bio-Electric Engineering, Communications, Control & Dynamical Systems, Digital Systems, Electronics, Electric Energy Systems, and Microwaves and Photonics. In addition, the EE students are expected to do an internship of approximately 12 weeks in the industry and to work towards a BSc thesis under supervision of a member of the academic staff in the fourth year.

Graduate program

Graduate courses in electrical engineering are offered in the following areas:

1. Bio electric Engineering
2. Communication Systems and Networks
3. Secure Communications and Cryptography
4. Control and Dynamical Systems
5. Digital Electronic Systems
6. Microwaves and Photonics
7. Microelectronic Circuits
8. Micro & Nano Electronic Devices
9. Power systems
10. Power Electronics & Electric Machines

The two-year Master of Science program consists of a number of core courses, electives courses, and a master's thesis. A minimum of seven courses are taken. The thesis work, to be carried out in the 2nd year, will be supervised by the faculty staff from one of the groups listed above.

The four-year PhD program comprises a number of advanced courses followed by a qualification exam in the 2nd year. Once qualified, the students will prepare a PhD thesis proposal, and after its approval their PhD research work will start, culminating in a final thesis which will be defended before a defense committee.

Bachelor Degree Program

1st year	2nd year	3rd & 4th year
1st semester • Math. I • Physics I • Physics Lab I • Introduction to Electrical Engineering • Fundamentals of Programming • English Language	**3rd semester** • Engineering Math. • Electrical Circuit Theory • Engineering Probability And Statistics • Electronics I • Electronics Lab I • Logic Circuits & Lab	**5th semester** • Communication Systems • Linear Control Systems • Power Systems Analysis I • Sensing and Measurement • Mathematical Methods in Engineering
2nd semester • Math. II • Physics II • Physics Lab II • Differential Equations • Electrical Circuits & Lab • Object Oriented Programming	**4th semester** • Electronics II • Electronics Lab II • Signals & Systems • Electro magnetics • Electrical Energy Conversion I & Lab • Computer Structure & Lab	**6-8th semesters** • Internship • Control Lab • Engineering And Environmental Ethics • BSc project I. II • Courses/labs in one of the following areas (18 credits):Electronics, Bio-Electric Engineering, Communication Systems & Networks, Electrical Energy Systems, Digital Systems, Control & Dynamic Systems, Microwaves & Photonics) • Elective Courses

Master Degree Program

Semester 1	Semester 2	Semester 3	Semester 4
3-4 obligatory and/or elective course	3-4 obligatory and/or elective course	MSc seminar MSc thesis research	MSc thesis research

International Cooperation

As world-class research is based on international cooperation, the Department of Electrical Engineering has focused a good portion of its activities on fostering such collaborations in past few years. At Dual-Degree level, a number of our PhD graduates have been awarded Dual-Degrees through joint PhD programs with University of Grenoble and University of Rennes in France, in addition to students participating in similar programs with Hong Kong University of Science and Technology (HKUST), all of which are among most prestigious universities in their fields.

Research

The Electrical Engineering Department has numerous general and specialized laboratories, as well as extensive facilities devoted to experimental studies and research programs. Research activities in the EE department are carried out within seven major groups,

Bio-Electric Engineering

Communication Systems and Networks(Communication systems, Secure Communications & Cryptography)

Control & Dynamical Systems

Digital Systems

Electronics (Microelectronic Circuits, Micro & Nano Electronic Devices)

Electric Energy Systems (Power systems, Power Electronics & Electric Machines)

Microwaves and Photonics

Moreover, the department accommodates two national centers of excellence (CoE), i.e., Communication Access Systems, Cryptography, and Power System Management & Control.

The research program of the EE department covers both fundamental and applied fields, and is carried out by 72 faculty members and more than 200 PhD students. Annually, about 30 PhD degrees are conferred, and more than 300 papers are published in reputable international journals and conferences. In addition, the EE department has industrial collaboration in diverse areas including control, power, electronics, communications and bio-engineering. Some of the current industrial projects involve design and development of electric vehicles for public transportation in collaboration with Iran Khodro Co. (The oldest Iranian automobile manufacturer) to overcome the air pollution problem of big cities, tooth color detection systems and automated irrigation networks to overcome the water shortage crisis.

Faculty members of the EE department have been involved in large number of direct research collaborations with universities in the US, Canada, Western Europe and Asia Pacific and have been awarded numerous international prizes for their research contributions. The depart-

ment is proud of having an exceptional body of alumni active at top research institutes and companies that offer seminars and workshops throughout the year, providing a basis for knowledge exchange at world class level. The EE department believes in further expanding its international activities by participating in large scale research projects funded by EU, Canada, Australia and far east countries in coming years and hence, playing an active role in edge of science and technology research activities.

Research Groups and Centers of Excellence

Department of Electrical Engineering

Dean : S. Bagheri Shouraki

Microwaves and Photonics

Dir : B. Rejaei

Communications systems and networks

Dir : F. Ashtiani

Electronics

Dir : Z. Kavehvash

Electric Energy Systems

Dir : H. Hosseini

Digital Systems

Dir: M. Namvar

Bioelectric Eng.

Dir : M. Jahed

Control & Dynamical Systems

Dir : A. Rezaeizadeh

CoE

Power System Management & Control

Dir : M. Vakilian

CoE

Communication Access Systems

Dir :B. Khalaj

Curriculum

Bachelor of Science Program

The 4-year Bachelor of Science program consists of two stages. The first five semesters are focused on providing the students with a broad foundation in basic sciences and electrical engineering. Courses in mathematics, physics, fundamentals of electrical engineering and humanities are offered with a total of 91 units. At the end of the fifth semester, students select a branch from 7 different areas in electrical engineering. Each branch comprises 5 courses and 3 labs (18 units). Besides the branch courses, the students may take elective courses (15 units) in the last three semesters. These elective courses include all courses and laboratories of the faculty of Electrical Engineering including branch courses and some approved courses from other faculties of science and engineering. The faculty provides clusters of relevant courses in a specific area that maximize synergy in the choice of elective courses, encouraging students to pursue their interests and agility in different up-to-date areas. During this program, the student completes 140 (or 142 depending on the type of family and population knowledge course) Units as shown below.

Bachelor of Electrical Engineering Courses	
Course Type	**Number Of Units**
General Education Courses (Table 1)	20 (22)
Basic Science Courses (Table 2)	23
Main Courses (Table 3)	64
Branch Courses	18
Elective Courses	15
Total Units	140 (142)

Table 1- General Education Courses - 20 (22) Units					
Orientation	**Required Units**	**Course Number**	**Course Title**	**Units**	**Description**
Theoretical Foundations of Islam	2	37445	Islamic Thought 1 (Origin and Resurrection)	2	This Course Is Mandatory.
	2	37446	Islamic Thought 2 (Prophecy and Imamate)	2	Prerequisite: Islamic Thought 1
		37447	Islamic Anthropology	2	
		37448	Social & Pol Rights In Islam	2	
Islamic Ethics	2	37126	The Phil Of Ethics (Educational Topics)	2	
		37123	Islamic Ethics (Foundations and Concepts)	2	
		37127	Life Style (Applied Ethics)	2	
		37128	Practical Mysticism in Islam	2	
Islamic Revolution	2	37626	Islamic Revolution of Iran	2	
		37627	Intro Constitution	2	
		37628	Pol Thought of Imam Khomeini	2	
		37634	An Introduction to Education	2	
History and Islamic Civilization	2	37618	Hist Islamic Cult & Civilization	2	
		37620	Anal Hist of Initial Islam	2	
		37622	The History of Imamat	2	
Islamic Sources	2	37489	Quran Subj Interpret	2	
		37490	Nahjol BalaGheh Subj Interpret	2	
The Literature	3	31119	Intro Persian Literature	3	
Language	3	31123	Foreign Lang	3	
Physical Education	2	30003	Physical Education	1	
		30004	Sport 1	1	Prerequisite: Physical Education
Family and Population Knowledge	0 or 2	37514	The Knowledge of Family & Population	0	
		37515	Knowledge of Family & Population	2	
Required Unit Totals	20 Or 22				

In the case of general education courses (Table 1), it should be noted that according to the University Education Council resolution, the "Family and Population Knowledge" course is offered in two forms "two units" and "one unit zero". The two-unit course (37515) is offered through oral lectures and has the usual evaluation procedure by means of a written exam. The zero unit course (37514) is, however, an online course with a pass (P) or fail (F) evaluation. Students who have taken the zero-unit course will graduate with 20 general units (140 units complete 22 general units (142 units in total). According to the University Education Council Act, a student can only take one course from the Education Center (course numbers starting with 37) per semester.

The compulsory courses in the Electrical Engineering Undergraduate Program are typically taken in the first 5 semesters, and provide basic knowledge in math and physics as well as an overview of electrical engineering.

In the remainder of the program, the students choose one of the branches of Electrical Engineering. The students are required to a pass 5 courses and 3 laboratories (18 units) in the chosen branch. In order to track the rapid development of knowledge and technology and emergence of new and interdisciplinary fields in electrical engineering, a suitable volume (15 units) of Elective courses is included in the bachelor's degree program. Elective courses offered by the faculty of Electrical Engineering include branch courses, as well as t certain courses offered by other faculties However, in order to properly synergize the elective courses, the faculty recommends a number of predefined elective clusters. Examples of recommended clusters are given below (This list is subject to change, please visit the faculty website).

Branch selection in the fifth semester is based on students' preferences, and their performance in the first 5 semesters.

It is possible to get an apprenticeship after completing 90 credits.

It is possible to take an engineering and environmental ethics course after passing 100 credits.

BSc project requires the completion of the courses in the first 5 semesters and the control lab.

It is also not allowed to take courses outside of the faculty program and those extra-faculty courses accepted as Elective courses.

	Table 2 - Basic Science Courses - 23 Credits	
Course Number	**Course Title**	**Units**
22015	Math. I	4
22016	Math. II	4
22034	Differential Equations	3
24011	Physics I	3
24012	Physics II	3
24001	Physics Lab I	1
24002	Physics Lab II	1
33018	General Workshop	1
25768	Fundamentals of Programming	3
	Total Units	23

Table 3 - Main Courses - 64 Credits		
Course Number	**Course Title**	**Units**
25720	Intro Elec Eng	0
33014	Electric Workshop	1
25768	Fund Of Programming	3
25759	Electrical Circuits & Lab	4
25731	Electrical Ckts Theory	3
25743	Log Ckts & Dig Sys & Lab	4
25031	Electronics 1	3
25002	Electronics Lab 1	1
25032	Electronics 2	3
25203	Electronics Lab 2	1
25732	Eng Prob And Statistics	3
25733	Electromagnetics	3
31114	Lang Elect	2
25735	Engineering Mathematics	3
25872	Math Metd In Eng	2
25741	Elec Energ Cnvrsn 1 & Lab	4
25753	Power Sys Analysis 1	3
25754	Cmptr Struct & Up & Lab	4
25742	Signals & Systems	3
25751	Communication Systems	3
25411	Linear Control Systems	3
25403	Control Sys Lab	1
25769	Sensing and Measurement	3
25700	Indust Training	0
25770	Eng Ethics & Environment	1
25780	Bs Project 1	1
25790	Bs Project 2	2
Total Units		64

Program Summary Chart - (Entries 98 and later)

Semester 1		Semester 2		Semester 3		Semester 4		Semester 5		Semester 6-7-8	
Course Name	Course Number	Course Name	Course Number	Course Name	Course Number	Course Name	Course Number	Course Name	Course Number	Course Name	Course Number
Math. 1	4	Math.2	4	Engineering Mathematics	3	Signals & Systems	3	Communication Systems	3	INDUST TRAINING	0
Physics 1	3	Physics 2	3	Electrical Circuits Theory	3	Electromagnetics	3	Linear Control Systems	3	Control Sys Lab	1
Physics Lab 1	1	Physics Lab 2	1	Engineering Probability and Statistics	3	Electronics 2	3	Power Systems Analysis 1	3	Engineering Ethics and Environment	1
Introduction to Electrical Eng.*	0	Differential Equations	3	Electronics 1	3	Electronics Lab 2	1	Sensing and Measurement	3	Bs Project 1	1
Fundamentals of Programming	3	Electrical Circuits & Lab	4	Electronics Lab 1	1	Electrical Energy Conversion I & Lab	4	Mathematical Methods in Eng.	2	Bs Project 2	2
English Language	3	Object Oriented Programming	3	Logical Circuits & Lab	4	Computer Structure & Lab	4	Electrical PROF Language	2	General Education courses	11
Physical Education	1	General Workshop	1	Sport 1	1	Electrical Workshop	1	General Education course	2	Selecting A cluster Of Electrical Engineering **	18
General	2									Elective Courses ***	15
Total	17	Total	19	Total	18	Total	19	Total	18	Total	49

* Introduction to Electrical Engineering Is Presented In a Variety of Presentations With The Presence of Scientific And Industrial Figures, Scientific Visits, Lectures And Film Screenings, Etc. And Aims to Familiarize Students with Electrical Engineering Capabilities and Features.

** Branch Courses Consist of 18 Units, Representing The Main Areas of Electrical Engineering. It Is Essential to Take At Least 5 Courses and 3 Labs from The Required Elective Course Selection.

*** Elective Courses at Least 15 Units of Courses Approved By The Board Of Education of The Faculty of Electrical Engineering In Accordance With The Relevant Criteria. Elective Courses are Recommended from The Set of Suggested Clusters.

Prerequisite – Synchronization Table

Semester Number	Name Of Course	Prerequisite	Synchronization	Synchronization and Synchronous of Two Courses
2	Math. 2	Math. 1		
	Differential Equations		Math. 2	
	Physics 2	Physics 1		Physics Lab 2
	Electrical Circuits & Lab	Introduction to Electrical Eng	Differential Equations	
	Object-Oriented Programming	Fundamentals of Programming		
3	Engineering Math.	Differential Equations		
	Electrical Circuits Theory	Introduction to Electrical Eng. - Differential Equations - Electrical Circuits & Lab		
	Engineering Probability and Statistics	Math. 2		
	Electronics 1	Electrical Circuits & Lab		Electronics Lab 1
	Electronics Lab 1			Electronics 1
	Logical Circuit & Lab	Fundamentals of Programming - Electrical Circuits & Lab		
	Sport 1	Physical Education		
4	Signals & Systems	Engineering Math.	Electrical Circuits Theory	
	Electromagnetism	Physics 2- Engineering Math.		
	Electrical Energy Conversion 1 & Lab	Physics 2- Electrical Circuits Theory		
	Electronics 2	Electronics 1- Electronics 1 Lab		Electronics Lab 1
	Electronics 2 & Lab		Electronics 2	
	Computer Structure & Lab	Logical Circuit & Lab	Math. 2	
	Electrical Workshop	General Workshop		
5	Communication Systems	Engineering Probability and Statistics - Signals & Systems	Differential Equations	
	Linear Control Systems	Signals & Systems		
	Power Systems Analysis 1	Electrical Energy Conversion 1 & Lab		
	Sensing And Measurement	Engineering Probability and Statistics - Logical Circuit & Lab -Electronic 2		
	Mathematical Methods in Eng.	Math. 2		
	Electrical Prof Language	English Language		

Branch Courses

Bio-Electric Engineering

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

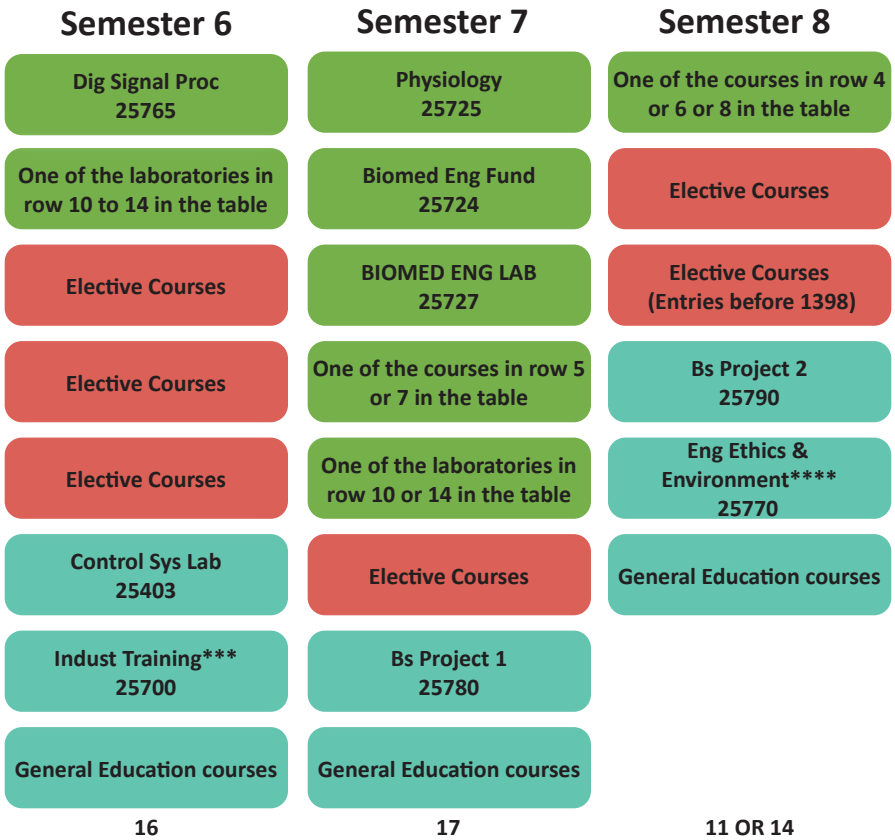
Row	Course Number	Course Name	nit Name
1	25725	Physiology	3
2	25724	Biomed Eng Fund	3
3	25765	Dig Signal Proc	3
4	25729	Ai & Biological Computation*	3
5	25728	Neuromuscular Contr & Modeling*	3
6	25749	Found Of Neuroscience*	3
7	25726	Biosensors *	3
8	25736	Biomed Elec Ckt Appl*	3
9	25727	Biomed Eng Lab	1
10	25723	Microprocessor Sys Lab**	1
11	25045	Biosensors Lab**	1
12	25746	Mach Learn & Vis Lab**	1
13	25043	Medical Sig & Img Proc Lab**	1
14	25044	Neuroscience Lab **	1

* Selected Courses - 2 Out Of 5 Courses.

** Selected Laboratories - 2 Out Of 5 Laboratories.

***It Is Possible To Get An Apprenticeship After Completing 90 Credits.

****It Is Possible To Take An Engineering And Environmental Ethics Courses After Completing 100 Credits.



Electronics

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

Row	Course number	Course name	Unit name
1	25761	Analog Electronics	3
2	25764	Rf Comm Circt	3
3	25772	Princ Solid St Device	3
4	25774	Pulse Technique And Digital Circuits	3
5	25771	Microprocessor Sys Dsgn*	3
6	25776	ASIC/FPGA Syst Dsgn*	3
7	25798	Solid State Devices*	3
8	25773	Filters & Network Synthesis*	3
9	25705	RF Com Crct Lab**	1
10	25706	Pulse Technique Laboratory**	1
11	25704	Analog Electronic Lab**	1
12	25028	IC Cad Lab**	1
13		Lab From The Faculty Of Electrical Engineering **	1
14		Lab From The Faculty Of Electrical Engineering **	1

* Selected Courses – 1 Out Of 4 Courses,

**Selected Laboratories - 3 Out Of 6 Laboratories.

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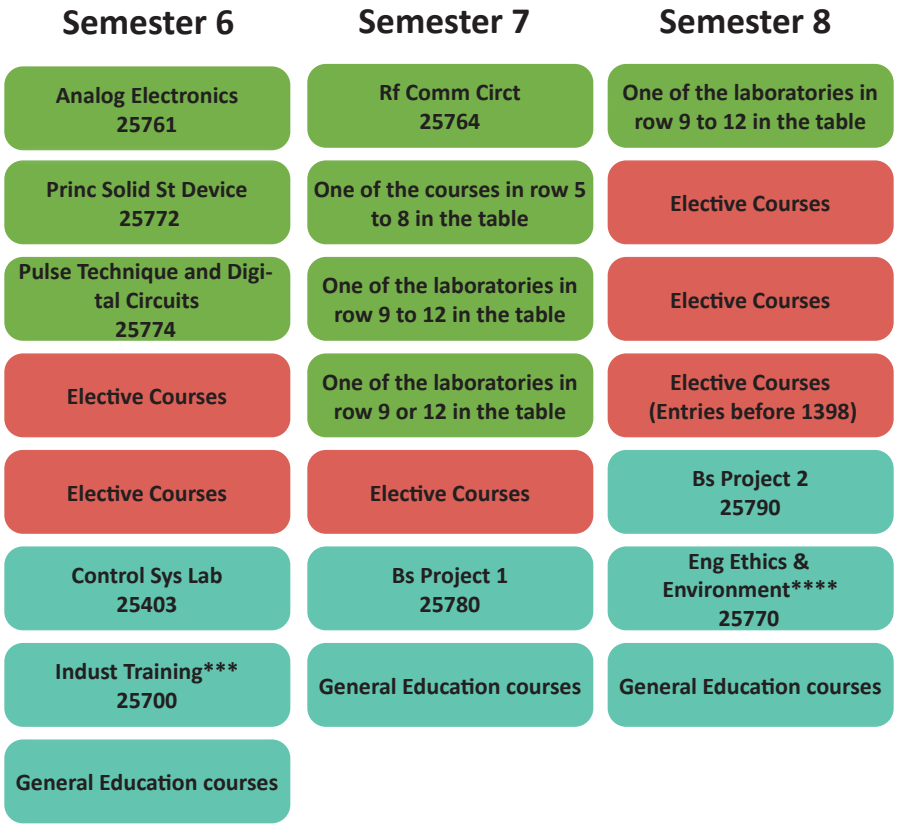


Communication Systems and Networks

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

Row	Lesson Number	Lesson Name	Unit Name
1	25763	Digital Comm	3
2	25765	Dig Signal Proc	3
3	25873	Computer Networks	3
4	25775	Int To Wireless Comm*	3
5	25737	Intro Machine Learn*	3
6	25756	Convex Optimization 1 *	3
7	25874	Fund Crypto Net Security*	3
8	25762	Em Field & Waves*	3
9	25048	Dsp Lab**	1
10	25701	Dig Com Lab**	1
11	25739	Python Prog Lab**	1
12	25746	Mach Learn & Vis Lab***	1
13	25723	Microprocessor Sys Lab***	1
14	25705	Rf Com Crct Lab***	1

* Selected Courses – 2 Out Of 5 Courses,

Selected Laboratories - 3 Out Of 3 Laboratories Or (2 Out Of 3 Laboratories, And *** 1 Out Of 3 Laboratories).

****It Is Possible To Get An Apprenticeship After Completing 90 Credits.

*****It Is Possible To Take An Engineering And Environmental Ethics Courses After Completing 100 Credits.

Semester 6	Semester 7	Semester 8
Digital COMM 25763	One of the courses in row 4 to 8 in the table	One of the laboratories in row 9 to 11 Or 12 to 14 in the table
Dig Signal Proc 25765	One of the courses in row 9 to 11 in the table	Elective Courses
Computer Networks 25873	One of the laboratories in row 9 to 11 in the table	Elective Courses
One of the courses in row 4 to 8 in the table	Elective Courses	Elective Courses (Entries before 1398)
Elective Courses	Elective Courses	Bs Project 2 25790
Control Sys Lab 25403	Bs Project 1 25780	Eng Ethics & Environment**** 25770
Indust Training*** 25700	General Education courses	General Education courses
General Education courses		
18	14	12 OR 15

Electric Energy Systems

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

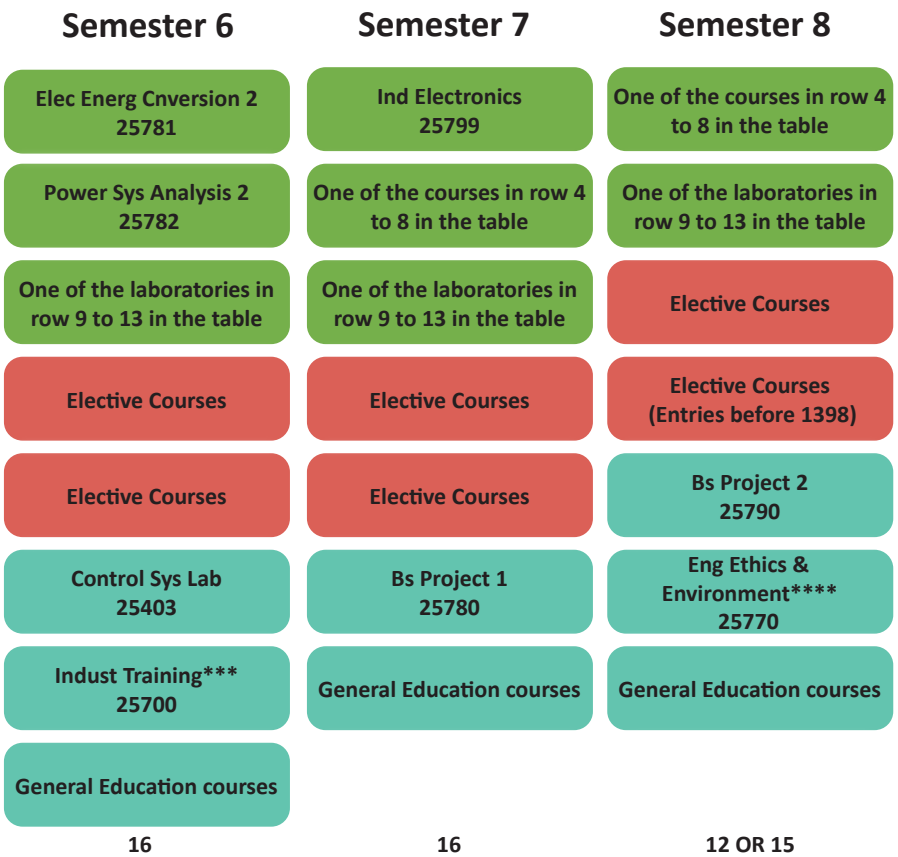
Row	Lesson Number	Lesson Name	Unit Name
1	25781	Elec Energ Cnversn 2	3
2	25782	Power Sys Analysis 2	3
3	25799	Ind Electronics	3
4	25783	Dielectrics & Hv*	3
5	25784	Electrical Installation *	3
6	25785	Elec Energ Gen Sys*	3
7	25786	Power Sys Protection *	3
8	25789	Automo Elec And Elctrnc Sys *	3
9	25712	Elec Energ Cnversn Lab2**	1
10	25713	Dielectrics & Hv Lab**	1
11	25205	Ind Electronics Lab**	1
12	25716	Elec Energ Sys Lab**	1
13	25722	Power Sys Protection Lab**	1
14		Lab From The School Of Electrical Engineering	1

* Selected courses – 2 out of 5 Courses.

**Selected Laboratories - 3 out of 5 laboratories.

***It Is Possible To Get An Apprenticeship After Completing 90 Credits.

****It Is Possible To Take An Engineering And Environmental Ethics Courses After Completing 100 Credits.



Digital Systems

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

Row	Lesson number	Lesson Name	Unit name
1	25771	Microprocessor Sys Dsgn	3
2	25776	Asic/Fpga Syst Dsgn	3
3	25755	Data Struct & Algo	3
4	25774	Pulse Technique and Digital Circuits	3
5	25738	Intro Robotic Sys*	3
6	25737	Intro Machine Learn*	3
7	25758	Embedded Systems*	3
8	25777	Advanced Programming *	3
9	25723	Microprocessor Sys Lab	1
10	25739	Python Prog Lab**	1
11	25717	Asic/Fpga Advanced Lab**	1
12	25706	Pulse Technique Laboratory**	1
13	25719	Adv. Prog Lab**	1
14		Lab from The School Of Electrical Engineering	1

*** Selected courses – 1 out of 4 Courses.**

****Selected Laboratories - 2 out of 4 laboratories.**

*****It Is Possible To Get An Apprenticeship After Completing 90 Credits.**

******It Is Possible To Take An Engineering And Environmental Ethics Courses After Completing 100 Credits.**

Semester 6	Semester 7	Semester 8
Microprocessor Sys Dsgn 25711	One of the courses in row 5 to 8 in the table	One of the laboratories in row 10 to 13 in the table
Data Struct & Algo 25755	Microprocessor systems Lab 25723	Elective Courses
Pulse Technique and Digital Circuits 25774	One of the laboratories in row 10 to 13 in the table	Elective Courses
ASIC/FPGA Syst Dsgn 25776	Elective Courses	Elective Courses (Entries before 1398)
Elective Courses	Elective Courses	Bs Project 2 25790
Control Sys Lab 25403	Bs Project 1 25780	Eng Ethics & Environment**** 25770
Indust Training*** 25700	General Education courses	General Education courses
General Education courses		
18	14	12 OR 15

Control & Dynamical Systems

Basic courses

Cluster Courses

Elective Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

Row	Lesson Number	Lesson Name	Unit Name
1	25791	Industrial Control	3
2	25792	Modern Control	3
3	25793	Digital Control	3
4	25794	Nonlinear Systems *	3
5	25756	Convex Optimization 1 *	3
6	25757	Mechatronics *	3
7	25737	Intro Machine Learn*	3
8	25738	Intro Robotic Sys*	3
9	25715	Modern Control Lab **	1
10	25707	Industrial Control Lab **	1
11	25708	Digital Control Lab **	1
12	25047	Mechatronics Lab **	1
13	25709	Nonlinear Systems Lab **	1
14		Lab from The School of Electrical Engineering **	1

*Selected courses – 2 out of 5 Courses.

**Selected Laboratories - 3 out of 6 laboratories.

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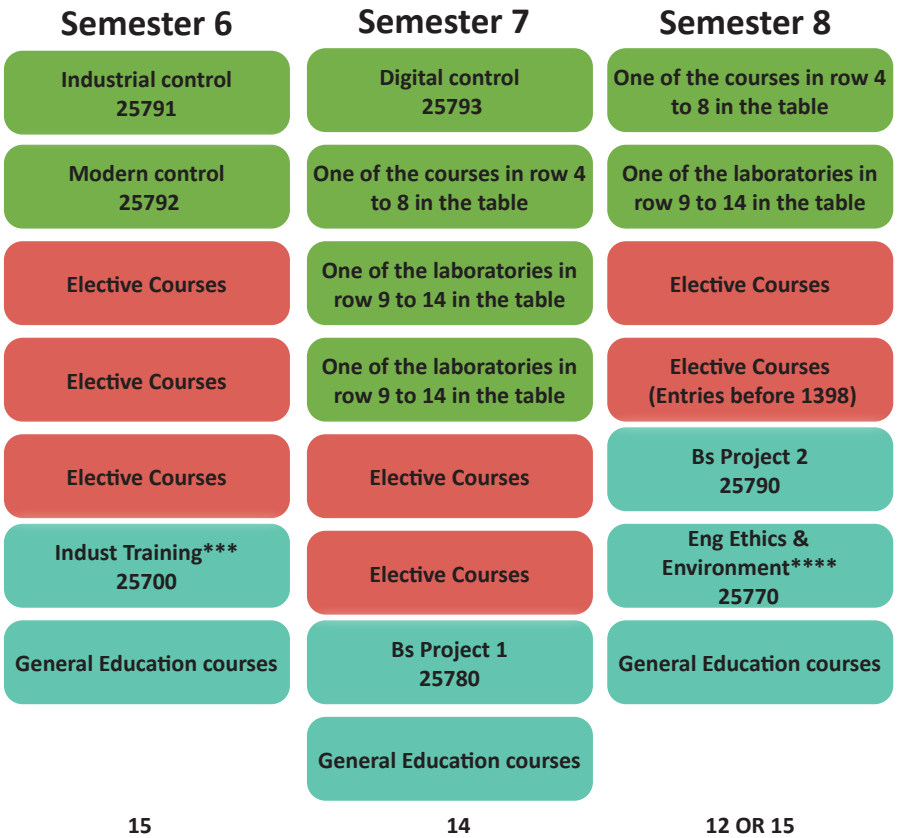


Microwaves and photonics

Basic courses

Cluster Courses

Elective Courses: Courses in the department, courses in the School of Electrical Engineering and courses approved by education from other colleges. The School of Electrical Engineering recommends taking courses from the introduced clusters.

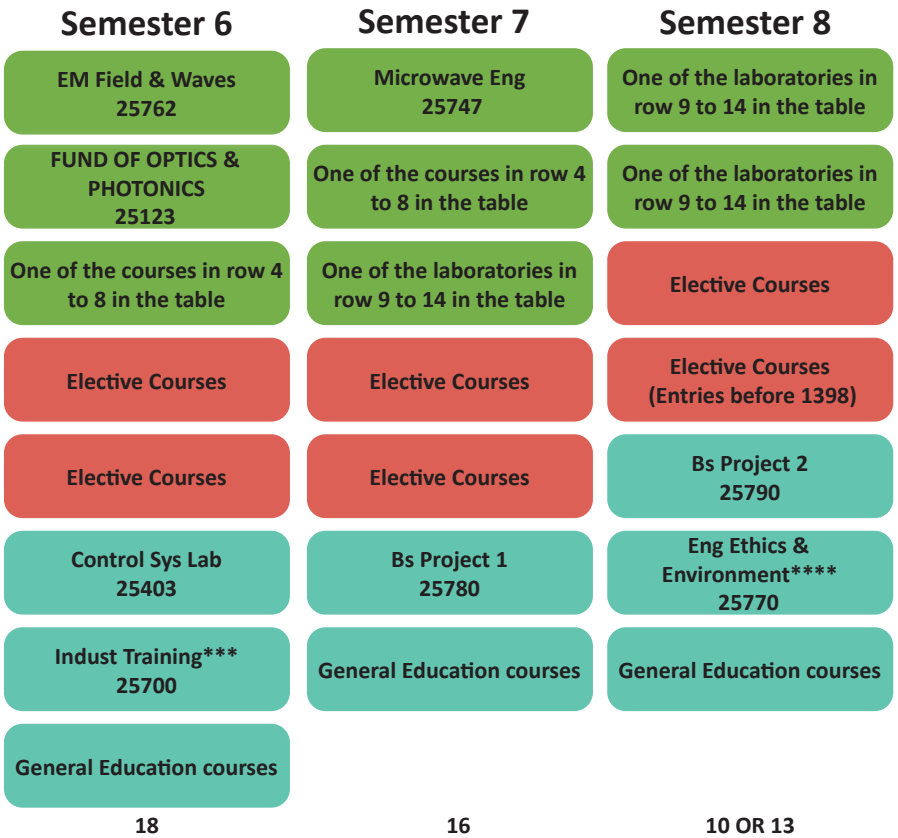
Row	Lesson Number	Lesson Name	Unit Name
1	25762	Em Field & Waves	3
2	25747	Microwave Eng	3
3	25123	Fund Of Optics & Photonics	3
4	25144	Antennas *	3
5	25764	Rf Comm Circt*	3
6	25875	Fiber Optics Comm *	3
7	25748	Quantum Electronics *	3
8	25142	Radio Wave Propag*	3
9	25046	Mwave Eng Lab **	1
10	25035	Antenna Lab **	1
11	25705	Rf Com Crct Lab**	1
12	25036	Compu Electromagnetics Lab **	1
13	25037	Optics & Photonics Lab **	1
14	25038	Mwave & Optics Dsgn & Fab**	1

*Selected courses – 1 out of 5 Courses.

**Selected Laboratories - 3 out of 6 laboratories.

***It Is Possible To Get An Apprenticeship After Completing 90 Credits.

****It Is Possible To Take An Engineering And Environmental Ethics Courses After Completing 100 Credits.



Elective courses

Elective courses from other faculties that are accepted by the faculty of Electrical Engineering are available in the list below:

Units	Course Number	Faculty of Management and Economics		Faculty of Industries	Course Number	Units
			Or	Basic Management	21633	3
3	44714	Prin of Econ Senior Students Are Not Allowed to Take This Course		General Economics 1 General Economics 2	21114 21115	2 2
3	44261	System Dynamics	Or	Systems Analysis 1	21981	2
3	44314	Project Management	Or	Project Control	21532	3
				Eng Economy	21131	3
				Intro op Research	21721	3
3	44719	Microeconomics				
3	44728	Macroeconomics				
3	44122	Mngmt Decision Models				
3	44713	Economy of Iran				
3	44004	Intro to Mot				
3	44021	Introduction to OB				
3	44772	Industrial Org				
3	44002	Entrepreneurship Prin				

Units	Course number	Faculty of Mathematical Sciences
4	22325	Math Analysis 1
4	22655	Numerical Analysis 1
4	22657	Numerical Analysis 2
3	22825	Discrete Math
3	22873	Automata Lang Theory

Units	Course Number	Faculty of Physics
3	24014	Physics 4
3	24113	Analytical Mech 1
3	24167	Thermodyn And Stat Mech 1
3	24313	Quantum Mech 1
3	24617	Solid State Phys 1
3	24314	Quantum Mech 2
3	24168	Thermodyn And Stat Mech 2
3	24144	Special Relativity

Units	Course Number	Faculty of Computer
3	40354	DESIGN OF ALGORITHMS
3	40364	PROGRAMMING LANGUAGES
3	40647	Parallel Processing
3	40384	Database Design
3	40424	Operating Systems
3	40324	ADV INFO RETRIEVAL
3	40417	Artificial Intelligence
3	40833	Speech Recognition

Cluster Courses

ROWS	COURSE NUMBER	DIGITAL SYSTEMS	UNITS
1	25771	MICROPROCESSOR SYS DSGN	3
2	25776	ASIC/FPGA SYST DSGN	3
3	25262	DIGITAL ELECTRONIC	3
4	25778	EMBEDDED SYSTEMS	3
5	25755	DATA STRUCTURE AND ALGORITHM	3

ROWS	COURSE NUMBER	ANALOG AND HIGH FREQUENCY ELECTRONICS	UNITS
1	25762	EM FIELD & WAVES	3
2	25773	FILTERS & NETWORK SYNTHESIS	3
3	25271	RF INTEGRATED CIRCUITS	3
4	25229	MICROWAVE IC	3
5	25274	INTEGRATED FILTER DESIGN	3

ROWS	COURSE NUMBER	ELECTRONIC DEVICES	UNITS
1	25798	SOLID STATE DEVICES	3
2	25269	ADVANCED SOLID STATE DEVICES	3
3	25231	SEMICOND TECH	3
4	25234	ADVANCED SOLID STATE PHYSICS	3
5	25762	EM FIELD & WAVES	3

ROWS	COURSE NUMBER	BIODEVICES	UNITS
1	25616	BIOMED ENG FUND	3
2	25736	BIOMED ELEC CKT APPL	3
3	25726	BIOSENSORS	3
4		BIOPHOTONICS	3
5		BRAIN COMPUTER INTERFACE (BCI)	3

ROWS	COURSE NUMBER	POWER ELECTRONICS	UNITS
1	25799	FUND PWR ELECT	3
2	25363	POWER ELECTRONICS 1	3
3	25785	ELEC ENERG GEN SYS	3
4	25332	DESIGN OF ELEMENTS PWR ELEC	3
5	25205	IND ELECTRONICS LAB	3

ROWS	COURSE NUMBER	ELECTRIC CARS AND DRIVES	UNITS
1	25799	INDUSTRIAL ELECTRONICS	3
2	25781	ELECTRIC ENERGY CONVERSION 2	3
3	25757	MECHATRONICS	3
4	25325 25365	ELEC MACHINES DSGN / CONTROLLED AC DRV	3
5	25712 25205	ELEC ENERG CNVERSN LAB2 / INDUSTRIAL ELECTRONICS	1

ROWS	COURSE NUMBER	ECONOMICS OF ELECTRICITY SYSTEMS AND MARKETS	UNITS
1	44714 44719	FOUNDATIONS OF ECONOMICS / MICROECONOMICS	3
2	25756	CONVEX OPTIMIZATION 1	3
3	25615	ENGINEERING ECONOMICS	3
4	25398	POWER SYSTEM PLANNING	3
5	25337	POWER SYSTEM OPERATION AND POWER MARKET / POWER SYSTEMS RESTRUCTURING	3

ROWS	COURSE NUMBER	RENEWABLE ENERGY SYSTEMS	UNITS
1		TECHNOLOGY AND APPLICATION OF RENEWABLE POWER PLANTS	3
2		ENERGY ECONOMY	3
3	25799	INDUSTRIAL ELECTRONICS	3
4	28602	ENERGY AND ENVIRONMENT	3
5		WASTE ENERGY TECHNOLOGY	3

ROWS	COURSE NUMBER	POWER SYSTEM PROTECTION AND CYBER SECURITY	UNITS
1	25786	POWER SYSTEMS PROTECTION	3
2	25765	DIGITAL SIGNAL PROCESSING	3
3	25167	DATA NETWORKS	3
4		DIGITAL PROTECTION OF POWER SYSTEMS	3
5		AUTOMATION IN POWER SYSTEMS	3

ROWS	COURSE NUMBER	BIOMOLECULAR SCIENCES AND TECHNOLOGIES	UNITS
1		MOLECULAR BIOLOGY	3
2		SYSTEMIC BIOLOGY	3
3		GENETICS AND EVOLUTION	3
4		COMPUTATIONAL GENOMICS	3

ROWS	COURSE NUMBER	BIOELECTRONICS	UNITS
1	25726	BIOSENSORS	3
2	25746	BIOMED ELEC CKT APPL	3
3	25798	SOLID STATE DEVICES	3
4	25123	FUNDAMENTALS OF OPTICS AND PHOTONICS	3
5	25772	PRINC SOLID ST DEVICE	3

ROWS	COURSE NUMBER	OPTICAL AND QUANTUM COMMUNICATIONS	UNITS
1	25123	FUNDAMENTALS OF OPTICS AND PHOTONICS	3
2	25875	FIBER OPTICS COMM	3
3	25748	QUANTUM ELECTRONICS	3
4	25169	STATISTICAL OPTICAL COMM	3
5		QUANTUM COMM SIGNALS	3

ROWS	COURSE NUMBER	COMMUNICATION SYSTEMS	UNITS
1	25763	DIGITAL COMM	3
2	25775	INT TO WIRELESS COMM	3
3	25128	INF & CODING THEORY	3
4	25181	RANDOM PROCESS	3
5	25129	CODING THEORY	3

ROWS	COURSE NUMBER	SIGNAL PROCESSING AND RADAR	UNITS
1	25765	DIGITAL SIGNAL PROCESSING	3
2	25553	COMPUTER VISION	3
3	25164	SIGNAL PROCESSORS	3
4	25197	RADAR SYSTEMS	3
5		SPECIAL TOPICS IN ELECTRICAL ENGINEERING (ADVANCED DSP)	3

ROWS	COURSE NUMBER	NETWORK CLUSTERING AND SECURITY	UNITS
1		COMPUTER NETWORKS / DATA COMMUNICATION NETWORKS	3
2	25874	FUND CRYPTO NET SECURITY	3
3		ADVANCED DATA COMM NETWORK	3
4	25824	GAME THEORY	3
5		FUNDAMENTALS OF BLOCKCHAIN TECHNOLOGY AND CURRENCY CODES	3

ROWS	COURSE NUMBER	MATHEMATICAL SCIENCES	UNITS
1	22325	MATHEMATICAL ANALYSIS 1	3
2	22655	NUMERICAL ANALYSIS 1	3
3	22657	NUMERICAL ANALYSIS 2	3
4	22825	DISCRETE MATHEMATICS	3
5	22873	THEORY OF LANGUAGES AND AUTOMATA	3

ROWS	COURSE NUMBER	PHYSICS	UNITS
1	24014	PHYSICS 4	3
2	24113	ANALYTICAL MECHANICS 1	3
3	24167	THERMODYNAMICS AND STATISTICAL MECHANICS 1	3
4	24313	QUANTUM MECHANICS	3
5	24617	SOLID STATE PHYSICS 1	3

ROWS	COURSE NUMBER	ROBOTICS	UNITS
1	25738	INTRODUCTION TO ROBOTIC SYSTEMS	3
2	25553	COMPUTER VISION	3
3	25089	NUMERICAL OPTIMIZATION METHODS	3
4	25792	MODERN CONTROL	3
5	25443	NEURAL NETWORKS	3

ROWS	COURSE NUMBER	HIGH VOLTAGES AND CURRENTS	UNITS
1	25783	DIELECTRICS & HV	3
2		POWER SUBSTATION STRUCTURE AND EQUIPMENT	3
3	25186	NUMERICAL METHODS IN ELECTROMAGNETISM	3
4	27017	SEL OF ENG MAT	3
5	25713	DIELECTRICS & HV LAB	3

ROWS	COURSE NUMBER	INDUSTRIAL ELECTRICAL AND ELECTRONIC SYSTEMS	UNITS
1	25799	INDUSTRIAL ELECTRONICS	3
2	25791	INDUSTRIAL CONTROL	3
3	25789	AUTOMO ELEC & ELCTRNC SYS	3
4	25784	ELECTRICAL INSTALLATION	3
5	25205	INDUSTRIAL ELECTRONICS LAB	1

Master of Science Program

The EE department of SUT offers a two-year Master of Science program in the following areas:

Bioelectric Engineering

Communication Systems and Networks

- Communication systems
- Secure Communications and Cryptography

Control & Dynamical Systems

Digital Electronic Systems

Electronics

Microelectronic Circuits

Nano- & Microelectronic devices

Electric Energy Systems

- Power Electronics & Electric Machines
- Power systems

Microwaves and Photonics

Converging technologies

- Neuroscience
- Genomics / Artificial Biology
- Smart machines
- Imaging and Bio Electromagnetism
- Bioelectronics and electromagnetic devices
- Biological and Molecular Telecommunications
- Wearable Electronics
- Quantum technology

In the first year, the students take a number of core- and elective courses. If the necessary academic requirements are met, students work towards completion of a master's thesis in the second year. Otherwise, three additional courses must be taken during the second year. The total number of units is 29 (including Master's thesis) and 32 for the thesis and non-thesis variants, respectively.

The qualified students can also join the converging technology program (CTP) in the 1st year. The EE.CTP students can join one of the educational & research groups of the program taking the related courses in their field of research areas. (Web address : ee. Sharif. edu/~web/converging- technologies/).

Superconductor Electronics Research Lab

Program Summary Charts

Bioelectric Engineering

Course Number/Name		Lab.	Units	Prerequisites
3 courses to be selected from:			9	
25625	Medical Imaging Systems			25051
25631	Bio-System Modeling			
25633	Bio-Signal Processing			25155
25623	Bio-Instruments			
25643	Computational Genomics			
2 courses to be selected from:			6	
25632	Bio-System Control			
25636	Medical Ultrasound			
25642	Medical Image Analysis & Processing			25155
25635	Neural Modeling			
Elective courses (2):			6	
25617	Pattern Recognition			
25618	Advanced Bio-Instruments			25623
25619	MRI Systems			
25192	Time-Frequency Representation			25155
25626	Vision in Man & Machine			25051
25156	Digital Signal Processing II			25155
25446	Fuzzy Logic & Applications			40151
25638	Bio-Signal Processing II			25633
25637	Robotics			
25234	Advanced Solid State Physics			
25089	Numerical Optimization Methods			
25137	Blind Source Separation & Sparse Signals			
25617	Pattern Recognition			
25443	Neural Networks‡			25411
25826	Compressed Sensing			
25639	Neuro-Muscular Control			
	MSc Seminar		2	
	MSc Thesis*		6	

‡ Allowed if 25617 is not taken

Communications (Communication Systems)

Course Number/Name		Lab.	Units	Prerequisites
25113	Advanced Communication Systems		3	25112,25181
25181	Random Processes		3	25111,25162†
Elective courses (5):			15	
25129	Coding Theory			
25128	Information & Coding Theory			25111
25166	Detection Theory			25181
25163	Estimation Theory			
25118	Queuing Theory			
25122	Switching Systems			
25165	Cryptography			
25158	Fourier Optics			25111
25197	Radar Systems			25111
25193	Satellite Communications			25111
25167	Data Networks			25112
25174	Advanced Data Networks			25167
25195	Data Communication & Networks			25111
25159	Speech Processing			25155
25157	Digital Image Processing			25155
25192	Time-Frequency Representation			25155
25164	Signal Processors			
25156	Digital Signal Processing II			25155
25171	Optical Communication Networks			
25169	Statistical Optical Communications			
25119	Optical Fibers			25141,25111
25161	Adaptive Filters			25155
25188	Broadband Access			25112
25105	DSP Laboratory			25155,25504
	Courses from other areas of EE (2 max)			
	MSc Seminar		2	
	MSc Thesis*		6	

Communications (Secure Communications & Cryptography)

Course Number/Name		Lab.	Units	Prerequisites
25165	Cryptography		3	
25172	Advanced Cryptography		3	25165
25126	Cryptography Mathematics		3	
25181	Random Processes		3	25111
Elective courses (3):				
25129	Coding Theory			
25128	Information & Coding Theory			25111
25113	Advanced Communication Systems			25181,25112
25167	Data Networks			25112
25174	Advanced Data Networks			25167
25195	Data Communication & Networks			25111
25159	Speech Processing		9	25155
25139	Information Hiding			25155/25181
25173	Computer & Network Security			
25191	Mobile Communications			25112
25127	Spread Spectrum Communications			25112
25833	Selected Topics in Cryptography			
25120	Special Topics in Communications			
	1 course from other areas of EE			
	MSc Seminar		2	
	MSc Thesis*		6	

Communications (Field & Wave Communications)

Course Number/Name		Lab.	Units	Prerequisites
25151	Advanced Electromagnetic Theory		3	25042
25194	Advanced Engineering Mathematics		3	
25154	Microwave & Photonic Solid State Devices		3	
2 courses from cluster A or B:			6	
Cluster A (Microwaves & Field Theory):				
25153	Microwaves II			25145
25182	Microwave Active Circuit Design			25153
25149	Advanced Antennas			25144
25186	Numerical Methods in Electromagnetics			25141
Cluster B (Optics):				
25836	Guided Wave Optics			25762
25837	Nonlinear Optics			25762
25186	Numerical Methods in Electromagnetics			25141
Elective courses (2):				
25185	Wave Scattering Theory			25141
25135	Laser & Photonic Crystals			25141,25223
25146	Microwave Measurement			25145
25175	Microwave Magnetic Devices			25141
25176	Wave Propagation in Wireless Comm.			25141
25184	Nonlinear Microwave Circuits			25145
25158	Fourier Optics		6	25111
25193	Satellite Communications			25111
25835	Terahertz Technology			25141
25832	Plasmonics & Metamaterials			25762
25133	PLL's & Frequency Synthesizers			25148
25831	Photonic Devices			25141
25187	mm-Wave Solid State Devices Courses from other cluster			
	MSc Seminar		2	
	MSc Thesis*		6	

Control & Dynamical Systems

Course Number/Name		Lab.	Units	Prerequisites
3 courses to be selected from:			9	
25426	Optimal Control			25431
25477	Multivariate Control			25431
25461	Robust Control			25431
25479	Nonlinear Control			25411
25194	Advanced Engineering Mathematics			
Elective courses (5):			15	
25765	Digital Signal Processing I			25742
25441	Estimation Theory & Optimal Filters			25181,25431
25444	System Identification			25114
25481	Model Predictive Control			
25161	Adaptive Filters			25155
25446	Fuzzy Logic & Applications			40151
25442	Inertial Navigation			25411
25478	Adaptive Control			25431
25447	Artificial Neural Networks & Applications			
25449	Intelligent Control			
25451	Robot Control I			25431
25452	Robot Control II			25451
25463	Advanced Instrumentation			25417
25428	Large Scale Systems 1 course (max) from other areas of EE			25426,25792
	MSc Seminar		2	
	MSc Thesis*		6	

Digital Electronic Systems

Course Number/Name		Lab.	Units	Prerequisites
25563	Microprocessors II		3	25535
25535	Advanced Computer Structure		3	25754,25771†
25561	Digital VLSI System Design		3	
1 course from			3	
25167	Data Networks			25112
25537	Parallel Programming & Architecture			25754,25777
Elective courses (3):			9	
25447	Artificial Neural Networks & Applications			
25536	Digital VLSI Architectures			25561
25540	Topics in Digital Systems			
25549	Fuzzy Systems			
25553	Computer Vision			25765
25555	Internet Programming			25777
25558	Computer Interfacing			25771
25570	Special Problems in Digital Systems			
25571	Special Topics in VLSI			25561
25576	Fault Tolerance Courses from other areas of EE (2 max)			
	MSc Seminar		2	
	MSc Thesis*		6	

Electronics (Microelectronic Circuits)

Course Number/Name		Lab.	Units	Prerequisites
25253	CMOS Circuit Design I		3	25761
25231	Semiconductor Technology		3	
25262	Digital Electronics		3	25032
Elective courses (4):			12	
25254	CMOS Circuit Design II			25253
25225	Integrated Circuit Design			25212,25033
25271	RF Integrated Circuits			25253,25148
25269	Advanced Solid State Devices			25234,25268
25274	Integrated Filter Design			25773
25568	VLSI Circuits			25031,25546
25214	Advanced Electronics			25212,25033
25261	Integrated Circuit Applications			
25252	Data Converter Circuit Design Courses from other areas of EE (2 max)			25033
	MSc Seminar		2	
	MSc Thesis*		6	

Electronics (Nano- & Microelectronic Devices)

Course Number/Name		Lab.	Units	Prerequisites
25268	Applied Quantum Mechanics		3	
25231	Semiconductor Technology		3	
25234	Advanced Solid State Physics		3	
25269	Advanced Solid State Devices		3	25234,25268
Elective courses (4):			12	
25246	Optical ICs			
25251	Principles of Superconductivity			
25242	Superconducting Devices			
25239	Optoelectronics			25042
25264	Semiconductor Device Characterization			25231/25223
25237	Engineering Quantum Electronics			
25247	Optical ICs II			25246
25245	Laser Technology & Application			25031,25041
25124	Photonic Crystals			25141
25238	Photonic Semiconductor Dev. Fabrication Courses from other areas of EE (2 max)			
	MSc Seminar		2	
	MSc Thesis*		6	

Electric Energy Systems (Power Electronics & Electric Machines)

Course Number/Name		Lab.	Units	Prerequisites
3 courses from				
25328	Electric Machine Theory			25326
25363	Power Electronics I			25213
25365	Controlled AC Drive		9	25328
25325	Electric Machine Design			25062
25351	Power Quality			
25395	Advanced Dielectrics & High Voltage			25341
Elective courses (4):				
25366	Flexible DC & AC Transfer Systems			
25353	Reactive Power Control			25311
25251	Principles of Superconductivity			25114
25348	Analysis of New Energy Sources			
25347	Power System Transients		12	25333
25339	Power System Reliability			25333
25394	Resonant Converters & Soft Switching			25363
25367	Modelling & Control of Power Converters			25363
25335	Non-Traditional Electric Machines			25781
	Courses from other areas of EE (2 max)			
	MSc Seminar		2	
	MSc Thesis*		6	

Electric Energy Systems (Power Systems)

Course Number/Name		Lab.	Units	Prerequisites
3 courses from				
25328	Electric Machine Theory			25326
25339	Power System Reliability			25333
25347	Power System Transients		9	25333,25311
25353	Reactive Power Control			25311,25333†
25338	Power System Dynamics I			25333
25355	Advanced Power System Operation			25333
Elective courses (4):				
25366	HVDC & FACTS			
25398	Power System Planning			25333
25309	Engineering System Reliability			25114
25348	Analysis of New Energy			
25351	Power Quality			
25339	Power System Reliability		12	25333
25346	Power System Dynamics II			25338
25337	Power System Restructuring			25311
25395	Advanced Dielectrics & High Voltage			25341
25334	Electric Energy Distribution Systems			25782
25089	Numerical Optimization Methods			
	Courses from other areas of EE (2 max)			
	MSc Seminar		2	
	MSc Thesis*		6	

PHD Program

The PhD program of the Electrical Engineering department spans four years. During the first year, students follow a number of advanced courses (15 units in total) in their field of specialization. The list of courses for each individual is tailored to his/her potential PhD research field and is composed in agreement with the PhD supervisor. After the successful completion of these courses, the candidate must take the PhD qualification exam in the second year.

Once qualified, the candidate will prepare a PhD thesis proposal which must be defended before a dissertation committee that is appointed by the graduate office of the Electrical Engineering department on the recommendation of the PhD supervisor. The dissertation committee is composed of University Professors and/or Industrial Researchers and comprises five members at least, of whom two must be from outside the Sharif University of Technology.

After the approval of candidates' PhD proposal, their research work will start, culminating in a final thesis. A progress report must be submitted every six month and the status of the ongoing research must be orally presented to a committee consisting of candidate's PhD supervisor, and the internal members of the dissertation committee. The final thesis must be defended before a defense committee comprising at least 3 internal and 2 external members appointed by the graduate office. (The defense committee may differ from the dissertation committee.) The degree of Doctor of Philosophy will be granted to the candidate if the research performed meets the academic standards of the Electrical Engineering department and is approved by the defense committee members.

Groups

Bio-Electric Engineering

General information

Director	Mehran Jahed
Academic Staff	Bijan Vosoughi Vahdat Mohammad Bagher Shamsollahi Emad Fatemizadeh Mehdi Fardmanesh Hoda Mohammadzade Sepideh Hajipour Ali Ghazizadeh
Research Laboratories	Biomedical Signal and Image Processing Lab (BiSIPL) Robotics and Machine Vision Lab (RMVL) Human Machine Interfaces Lab (HMIL) Neuroscience Laboratory
Contact Information	Tel: (+98) 21-66165937 jahed@sharif.edu

Research

The standard of living in today's modern societies depends, to a large extent, on progress in electrical engineering. Recent advances in electrical engineering (particularly bioelectric engineering) have influenced biological sciences and healthcare like no other discipline. Research carried out in the Bioelectric Engineering group of the EE department is at the forefront of this field, with four main subgroups consisting of researchers working tightly together to find efficient solutions for related real-world problems. The main focus of these subgroups is outlined below.

Biomedical Modeling and Control

Research activities in this subgroup include biomedical modeling and control of human physiological systems such as the heart and neuromuscular system, as well as design and modeling of prosthetic and assistant devices. In addition, research is conducted in the areas of bio-robotics, path planning, virtual and augmented reality, wireless sensor network and stereo vision, frequently with an emphasis on rehabilitation. The application of artificial intelligence in medicine and biology is another research topic in this subgroup. Some of the most promising projects that are currently running are "Control of exoskeleton system as an assistive device for human's upper extremity", and "Estimation of tissue deformation from ultrasound images in needle insertion procedures", to name a few.

Medical Image Processing

The main goal of this subgroup is to develop image processing techniques that use different biomedical images captured via x-ray, ultrasound, MRI, nuclear medicine and optical imaging technologies for both diagnostic and therapeutic purposes. To this end, various research projects are conducted in the fields of noise cancellation, registration, localization, machine learning and statistical pattern recognition. Other research activities include bio informatics and biological data analysis and processing. “Analysis and processing of high angular resolution diffusion images”, “Functional imaging of brain regions in the meth addicts” and “the estimation of blood pressure using video images of human face” are some examples of the recent research projects.

Biomedical Signal Processing

Biomedical signal processing is a combination of techniques and procedures used to automatically render noisy recorded signals into non-trivial information that are used to enhance monitoring, diagnosis and treatment. This subgroup focuses on developing novel methods for brain signal processing, brain source localization and cardiovascular signal processing. For example, various methods have been developed for ECG denoising, ECG fiducial point extraction, fetal ECG extraction and heart abnormality detection by Dynamic Bayesian Networks. Studies have also been carried out on semi-blind source separation and tensor decomposition techniques for EEG noise cancellation. Another major research topic of this subgroup is Brain Computer Interface (BCI) due to its increasing impact on human life. Other research activities include developing theoretical algorithms and their hardware implementations for medical and health-care issues. Implementation of EEG classification algorithms on FPGA, and development of a high-accuracy method for the cuff-less estimation of blood pressure using PPG signal are projects running in the Biomedical Signal Processing subgroup.

Bioelectronics and Bio-Optical Devices and Circuits

Research in this subgroup involves all aspects of research and development of electronic devices and circuits for bio-applications as well as use of biological materials and biological architectures for information processing systems and new devices. Bioelectronics, specifically bio-molecular electronics, is described as ‘the research and development of bio-inspired (i.e. self-assembly) inorganic and organic materials and of bio-inspired hardware architectures for the implementation of new information processing systems, sensors and actuators, and for molecular manufacturing down to the atomic scale’. The research topics in this subgroup include thermal (IR) and THz sensors and imaging, bioelectric field sensors and detection systems, DNA conductivity characterization and analysis, design of Self Powered Artificial Retina, noninvasive Glucometry, Biomagnetic sensors and SQUID based Magnetocardiography (MCG).

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include developing theoretical algorithms and their hardware implementations for medical and health-care issues. Implementation of EEG classification algorithms on FPGA, and development of a high-accuracy method for the cuff-less estimation of blood pressure using PPG signal are projects running in the Biomedical Signal Processing subgroup.

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Collaboration

Many of the projects in our group are carried out in collaboration with international research laboratories, such as LTSI lab., University of Rennes 1, Rennes, France and Gipsa Lab., University of Grenoble, Grenoble, France. Moreover, some joint projects are conducted in collaboration with national research institutions, such as Ears, Nose & Throat, Head & Neck Research center and Department, Hazrat Rasoul Akram Hospital, Iran University of Medical Sciences (IUMS) on the subject of Tinnitus and its extended effects.

Communication Systems and Networks

General information

Director	Farid Ashtiani
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Research Laboratories	Ambient Intelligence Research Lab Communication & Biological Network Analysis & Design Lab Data Network Research Lab Information Systems and Security Lab Lab on Advanced Networked Decision Systems Multimedia and Signal Processing Lab Radar and Electronic Warfare Lab Signal Processing Lab Wireless Research Lab Sharif Blockchain Lab Quantum Communication & Information Science Research Lab
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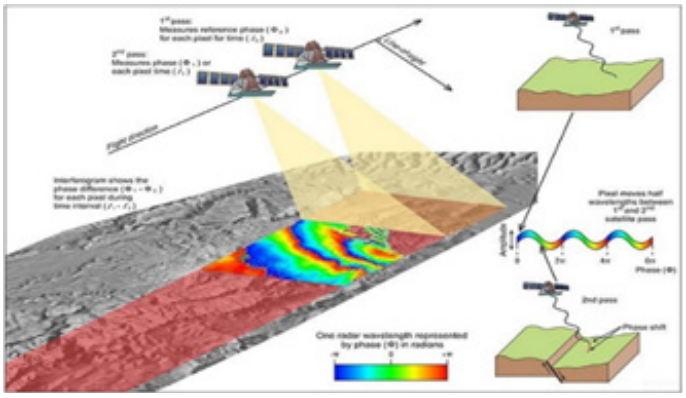
Research conducted in the Communications Systems group focuses on two main disciplines of Electrical Engineering namely Communications Theory and Signal Processing. Modern communications theory is preoccupied with investigating new ideas and methods for accommodating the exponential growth in data rates and coverage of broadband services throughout the world, as well as diversity of new Quality of Service requirements. Addressing these challenges is of paramount importance for the development of technologies such as 5G which is expected to become widespread soon. The growth of large-scale networks to appear in the so-called Internet of Things is another key challenge that communication systems research will face in coming years. As an example, topics such as Ambient Intelligence used in wide range of Smart Location Based services are now gaining more momentum, bringing in many new multi-disciplinary ideas from Machine Learning and Artificial Intelligence.

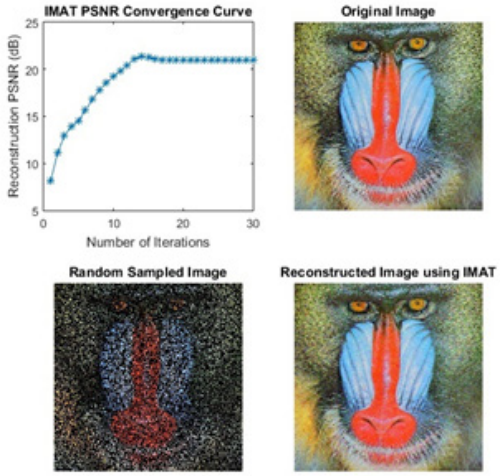
Future data networks should be able to handle human-human, human-things and things-things intercommunications. Networks are required to carry more traffic, support higher density of nodes, accommodate much less delay, cover larger areas, consume far less energy and be much more reliable. Here, the convergence of various fixed and mobile technologies and networks adds to the complexity. Part of the Communication Systems group research in this field focuses on new technologies that enhance not only the physical and multiple access layers of wireless and optical networks, but also provide new solutions at network layer as well. In particular, attention is paid to cognitive and collaborative radio techniques, optical spread spectrum techniques, routing algorithms, cross layer optimization and software defined networking (SDN). Network power consumption and operation efficiency are addressed through resource optimization and management, network scheduling, game theory and mechanism design. Attention is paid to energy harvesting as a novel technology through which wireless devices can have perpetual lifetime. However, the intermittent and stochastic nature of the harvested energy brings up new challenges to the design of the wireless devices.

Using information theoretic methods, research is also carried out on new algorithms and performance bounds of both wired and wireless systems comprising not only simple point to point connections, but also more complicated network systems, involving relay nodes, multiple access, and broadcast schemes. With the recent growth of interest in Biological systems, part of activities in the group has also been recently focused on topics such as

Molecular Communications, Genomics Signal Processing and Systems Biology with wide applications in drug delivery and design.

Signal Processing research in the group cover a number of topics, from voice and image processing to sparse systems and blind source separation. Here, emphasize lies on leading-edge technology-related problems, as well as hot fundamental problems in signal processing theory. Theoretical signal processing mainly deals with mathematical models governing signal types and acquisition devices. These models are further studied to design optimal or suboptimal processing techniques. The applications of





such models and techniques in real world signals such as audio, speech, image and video are studied under applied signal processing. In this case, one might try to further fine tune the theoretical tools to obtain tailored methods for specific applications.

Three Iranian National Science Foundation (INSF) Research Chair Awards on Network Information Theory and Security, Signal Processing, and Molecular Communications and a Type-Approval Test Lab for mobile base stations are part of achievements of this group in recent years. In addition, many faculty members have well-established connections with many universities and research centers in the world including EPFL, TU-Berlin, HKUST, KTH and Georgia Tech to name a few. Such interactions are at the core of the belief that world class research relies on the key pillar of collaboration among researchers.

International Cooperation

The group has participated in various projects involving many universities and international Research Labs including:

Technical University Berlin

Technical University Dresden

Technical University Darmstadt

University of Oulu (Finland)

Tecnalia Research Center (Spain)

CUHK (Hong Kong)

University of Ottawa

Australian National University

Hong Kong University of Science and Technology

Chalmers University of Technology

GIPSA-lab in Grenoble, France

Center for International Scientific Studies and Collaboration (CISSC)

European Research Council (ERC)

Control & Dynamical Systems

General information

Director	Amin Rezaeizadeh
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Research

Control Engineering is the science of extracting useful work from physical phenomena. It predates the advent of electricity, with early control systems being purely mechanical. However, following the domination of electricity as the primary source of generation and transportation of power, sensing, actuation, and computation, the application of control engineering is currently based on electron devices.

Control engineering and its related fields will likely play a crucial role in future sustainable development of the Earth. Since our resources are bounded, survival of life as we know it will seize to exist unless we either discover new ways in which we can use our resources more efficiently to achieve the same outputs, or to extract more output from the amount of resources we use. Both of these heavily rely on advent of advanced control solutions in - and not limited to - the following areas:

Efficient production of various forms of power. This includes mechanical from chemical such as in internal combustion or gas-turbine engines, electrical from mechanical such as in all kinds of generators used in wind, gas, steam, turbines, or electrical from light and heat such as in renewable energies.

Optimal harvesting of raw material in the production of consumables such as steel, paper, wood, petrochemicals…

Intelligent and autonomous healthcare systems which are becoming increasingly critical as the earth's population ages, and an increasing amount of the human workforce are required to care for those who are out of work. In several countries, the ratio of retired to working people

is almost 1 to 1.

Intelligent management of resources. Consider for example the simple case of transportation. The roads in most developed countries have reached their capacity for human drivers. This is because the speed with which the human brain makes decisions is fixed (and slow). Therefore the faster you drive, the more space should exist between the vehicles. At 100km/h, the safe distance for a human driver with the vehicle in front is 60 meters. This means only 10% of the road surface is occupied at any one time. Autonomous self-driving cars with advanced sensing and control technologies can significantly increase the road utilization and increase effective transportation throughput without having to build any new roads.

It is evident that control engineers will play a crucial role in the technological transformation which will and must occur in the following decades. The mission of the Control Engineering group at the department of Electrical Engineering is precisely to train engineers which are ready to face precisely these challenges.

The control group has a rigorous and well-rounded training program which is delivered by esteemed academics with an international research record, and is served by several educational and research labs. This is complimented by several industrial projects which are managed by group members.

The main research activities of the current group members are:

- Modelling, analysis and control of fractional order systems.
- Various aspects of Model Predictive Control systems, such as distributed MPC, non-linear MPC, multi-model MPC
- Modeling and optimal control of large scale systems, networks, and interconnected systems.
- Multivariable control systems with an emphasis on industrial applications.
- Networked control systems, control over wired or wireless networks.
- Multi-agent control systems, consensus problems, obstacle avoidance problems.
- Industrial Control Systems, PID, PLC, and DCS systems.
- Optimization algorithms, convex algorithms, semi-definite programming, evolutionary algorithms
- Robotics, Humanoids, and distributed robotics systems, co-operative robotic systems
- Robust and Nonlinear control.
- Instrumentation and sensing for industrial processes.

The research activities are organized in several research labs which are headed by one of or more of the academic group members.

Digital Systems

General information

Director	Mehrzad Namvar
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Research Laboratories	Artificial Creatures Laboratory Intelligent Digital Systems Laboratory Advanced Integrated Design Laboratory Microprocessor Research Laboratory Robotics Laboratory
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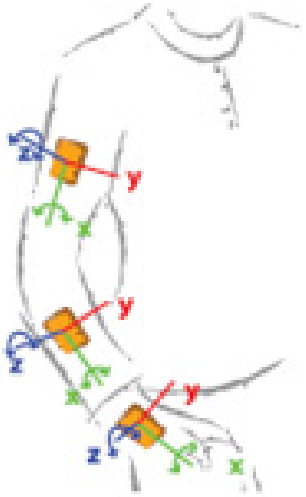
Research

VLSI Systems

Very-large-scale integration (VLSI) is the process of building small-scaled electronic circuits, called electronic chips, which are used in nearly all electronic equipment, almost everywhere in the world. These days, the dimension of the main building blocks of these electronic chips, i.e. transistors, has been reduced to a fraction of a micrometer. With the aid of nanotechnology, the size of transistors may approach several nanometers which makes VLSI circuits faster. Large electronic chips today contain several hundreds of millions of transistors. The VLSI chips of a figure-tip size can provide functions that were delivered by thousands of print circuit-boards before.

The VLSI research has many aspects. It starts from architectural design aspects where efficient architectures using pipelining, parallel processing, folding and re timing techniques are employed to meet today's challenging

hardware specifications. It then goes to the next level, where the architecture is translated to various transistor configurations, with all transistors must be properly placed and connected so that the entire circuit can operate at high frequencies. The power consumption of circuits needs to be reduced. The reliability and testability must be addressed. It is worth mentioning that the VLSI design is closely related to fabrication processes and therefore research on solid-state materials is also performed.



VLSI research in the Digital Systems group aims at enhancing the technology in its design, test and architecture aspects. We focus on efficient VLSI architecture design to address the challenging specifications of future next generation systems such as next generation wide band wireless communications, biomedical research, internet of things, mobile health, and imaging systems. The targeted specifications may vary depending on the target application but includes low-power design, high throughput systems and energy efficient gadgets. Some of the active projects in Digital Systems group cover VLSI implementation of biomedical signal processing algorithms, architecture/algorithm design for 5G communication systems, high-throughput massive MIMO systems, ASIC/RTL digital circuit design, and algorithmic aspects of wireless networks.

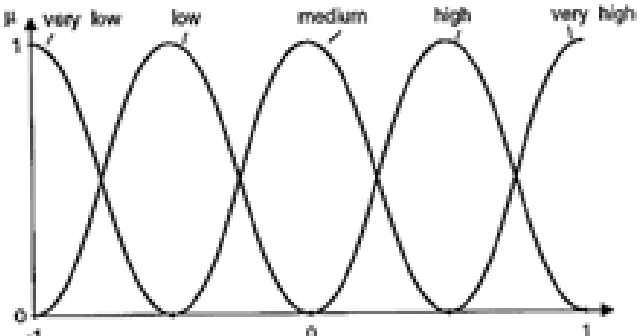
Computer Architecture

Computer architecture involves the study of different techniques in design and optimization of processors, processor-based systems and their memory and I/O sub-systems. It ranges from tiny micro controllers to large-scale cloud servers. A wide range of research topics fall in this category including parallel processors, virtualization and cloud computing. In particular, parallel processing involves both the study of parallel processors and design and optimization of algorithms which execute on parallel processors. Today, parallel processors are found in many systems including low-power smart watches, mobile processors, desktops and large scale servers.

Parallel implementation of machine learning algorithms on mobile GPU is an example of research topics that are being conducted in Digital Systems group. In particular, source code for the implementation of convolutional neural networks has been recently released publicly by this group at https://github.com/ENCP/CNNdroid

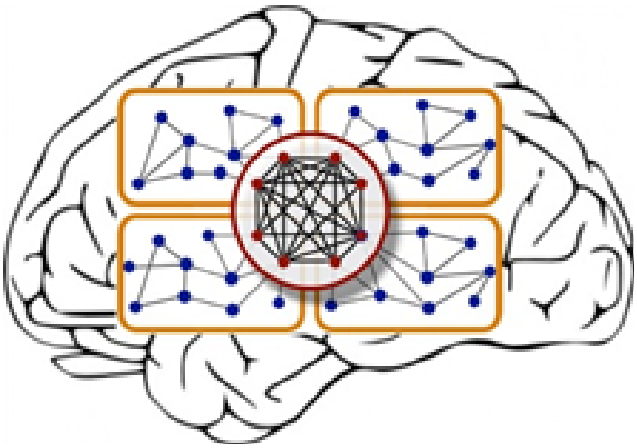
Artificial Intelligence

Artificial intelligence is, nowadays, one of the most popular and powerful fields of research whose main goal is to understand how an artificial system or algorithm can be trained to classify or regress specific patterns. Statistical learning, also called machine learning or pattern analysis, investigates methods of learning using statistical mathematics. Here, several patterns are used for training the system after which the test patterns are recognized or classified by the trained system. Theoretical development of learning methods, and application of machine learning



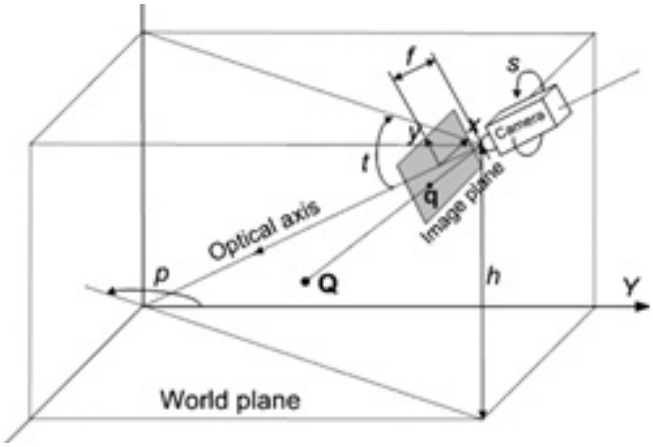
for recognition of face, action, speech and biomedical signals such as EEG, ECG and EMG are examples of research conducted in Digital Systems group.

Another popular and powerful learning method is based on **Artificial Neural Networks (ANNs)** that were inspired by biological neurons in brain. ANN is a powerful tool for learning, classification, clustering and optimization. Deep learning, a specific form of ANN, has recently attracted much attention due to its high accuracy.



It is expected that mobile phones will soon possess dedicated processors for deep learning algorithms. Moreover, researchers have recently combined various concepts from neural networks and Fuzzy logic to arrive at ANFIS and Fuzzy-ART systems.

Computer vision, also called **machine vision** or **image analysis**, is another key area of research within the Digital Systems group. Computer vision deals with analyzing images or frames of video in order to understand the concept and meaning of the image like humans. Image understanding, semantic processing, calculating camera model and image transformations such as panorama pictures are among the goals of computer vision. Dealing with two- and three-dimensional interest points in detection, description and tracking is another research area in the Digital Systems group. Other topics include activity recognition, face analysis, surveillance systems, image warping, tracking suspicious objects and object recognition and detection.



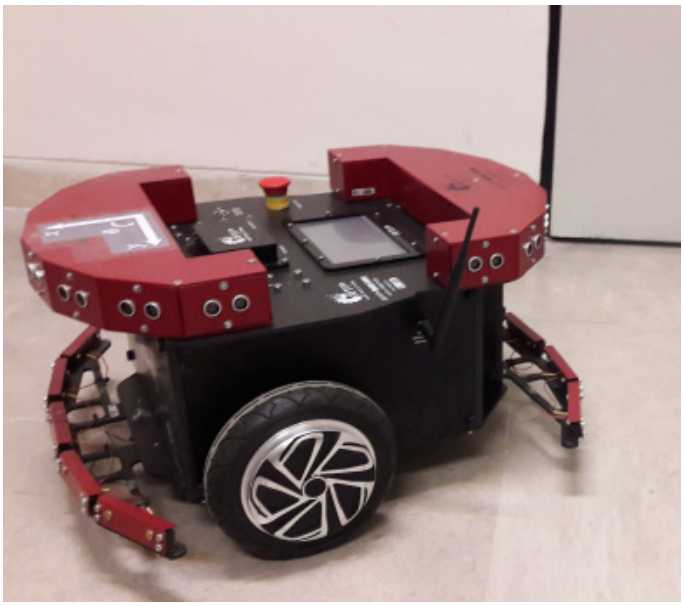
Data Network Research

Today, the demand for high speed data connectivity in fixed and mobile networks, and the need to ensure the desired quality of services for users, have created enormous challenges for the research community. Future data networks should be able to handle human-human, human-things and things-things intercommunications. Networks are required to carry more traffic, support higher density of nodes, provide much less delay, cover larger areas, consume far less energy and be much more reliable. Convergence of various fixed and mobile technologies and networks adds to the complexity.

Data Network Research Lab (DNRL) is focused on addressing the challenges of the future networks and the evolution of technology. Part of the research in this lab focuses on the new technologies that enhance the physical layer and multiple access capabilities of wireless and optical networks. We do research on topics such as cognitive and collaborative radio technologies and optical spread spec-

trum techniques, new evolving technologies in higher layers of networks such as routing algorithms, cross layer optimization and software defined networking (SDN). Other topics of interest includes increasing the efficiency of network operation by optimization of its resource management and addressing challenges such as network reliability and power consumption.

Robotics Laboratory



Electronics

General information

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Research Laboratories	Advanced Integrated Circuit Design Lab Integrated Photonic Design Lab Integrated Circuit Test and Measurement Lab Integrated Circuit Design Lab Nano and Microtechnology Lab Nano Microscopy Lab Superconductor Electronics Research Lab Semiconductor Device Simulation Lab Optics and Terahertz Lab Advanced Radio Systems
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Research

Microelectronic Circuits

Recent advances in wireless communication theory as well as biomedical science, stimulates design and implementation of novel, low-power, area-efficient and low-cost circuits and systems. In several applications, which require high data rate or bandwidth, the operational frequency is pushed to millimeter-wave, terahertz and optics. Considering the high propagation loss, and low transmitted power at these bands, efficient, low-power and low-noise design techniques must be utilized, which usually requires Electromagnetic full-wave analysis of the circuit. On the other hand, in many applications the area or maximum power consumption of the device is limited by strict constrains. Particularly, in consumer electronics the IC cost is proportional to its area and power consumption which affects the battery life. Furthermore, there are cases, such as satellite communication or radar, where high transmitted power, highly linear transmitters, or receivers with high sensitivity are required. Circuit design for each of the above classes of applications requires different skills and tools.

The emphasis in Microelectronic Circuits group is on design of circuits and systems for various wireless applications such as cellular communication, phased array systems, satellite communication, GPS receivers, RFID systems, biomedical sensors, automotive radar, and RF power harvesting. To achieve these goals, different circuit blocks are designed, including efficient power amplifiers, low noise amplifiers, phase-locked circuits, frequency synthesizers, mixers, modulators and demodulators, low phase-noise oscillators, frequency converters, phase-shifters, and analog to digital converters (ADC).

Our objective is to teach and train our students at the highest level of semiconductor industry. This objective is achieved through multiple courses on circuit theory and analog design, constantly updated lab experiments, design projects using advanced CAD tools, as well as practical projects ranging from board-level to integrated circuits design and implementation. The focus of Electronics education in our group is on the improving students' ability in analysis of BJT and CMOS transistor circuits through deep understanding of device behaviour, and circuit modeling. Moreover, our students are trained to design and synthesize functional circuits considering practical behavior of transistors at low and high frequencies, as well as environmental effects, such as noise, emission and temperature variation.

Nano- & Microelectronic devices

Microelectronics technology has been progressing exponentially since the invention of the first transistor, to the point which nowadays every aspect of our life is impacted by it. As we all know, things are different at the

IC Design Laboratory

nanoscale. Hence, nanoelectronics is not just the continuation of microelectronics to the nanometer range but a new playground for innovation and invention. Many breakthroughs in science and technology are expected in this field in the near future.

Our research interests focus on many aspects of micro/

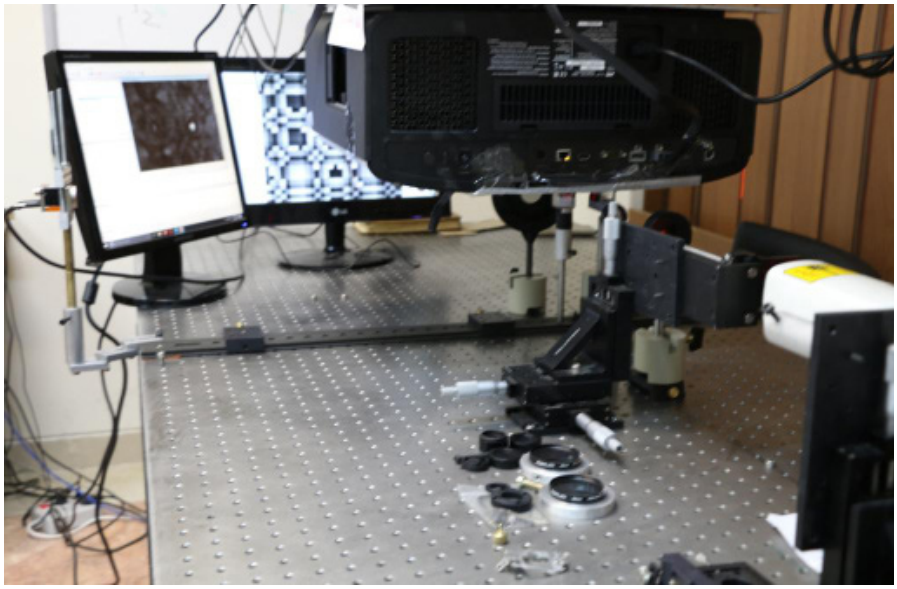
nano sciences and technologies including subjects from atoms to systems. This wide spectrum of research can be categorized based on different research labs into six core areas as:

1. **MicroTechnology and Integrated Photonics Lab:** Design, fabrication, characterization, and application of Micro and Nano-structures; Modeling and fabrication of plasmonic and nanophotonics devices; Microscopy and Nanoscopy techniques based on conventional and near-field methods (STM, AFM, SNOM); Biophotonics including the development of the novel imaging systems; High-efficiency solar panels; Fabrication of single and multi-wall carbon nanotubes; Integrated photonics; Spectroscopic systems
2. **Quantum Nanoelectronics Research Lab:** Quantum transport in nanoelectronics devices; Electronic/optical/phononic/Magnetic properties of 2D materials; Spintronics; Plasmonics; Organic Electronics devices; Optoelectronics; Development of in-house simulation software based on tight-binding and density function theories
3. **Superconductive Electronics Research Lab (SERL):** Principles, fabrication, and applications of semiconductor and high-TC superconductive electronic devices and Circuits, THz and infrared detectors, rf-SQUID and dc-SQUID magnetometers and gradiometers, flux-Gates and proton precession magnetic sensors, Josephson junction arrays, Transformers and microwave resonators; Ultra-low noise circuitry and cryogenic systems; Thin-film fabrication (MOD, CVD, Sputtering); Bioelectronics, microfluidic devices, and biosensors; 2D material based devices (in collaboration with CNAM); Hybrid circuits and microelectronics
4. **Quantum Electronics Lab:** Photonic Crystals; Phoxonic crystals; Quantum Optomechanics; Quantum electrodynamics; 2D bipolar junction transistors; Numerical/FDTD techniques for simulation of photonic devices; Optomechanical crystals; Modeling of nano-devices
5. **Giga-Scale Integration Lab:** Simulation and modeling of nanostructure devices; CNT- and graphene-based nanoelectronics; Electromechanical resonator-based sensors; On-chip GSI Interconnects (modeling/signal

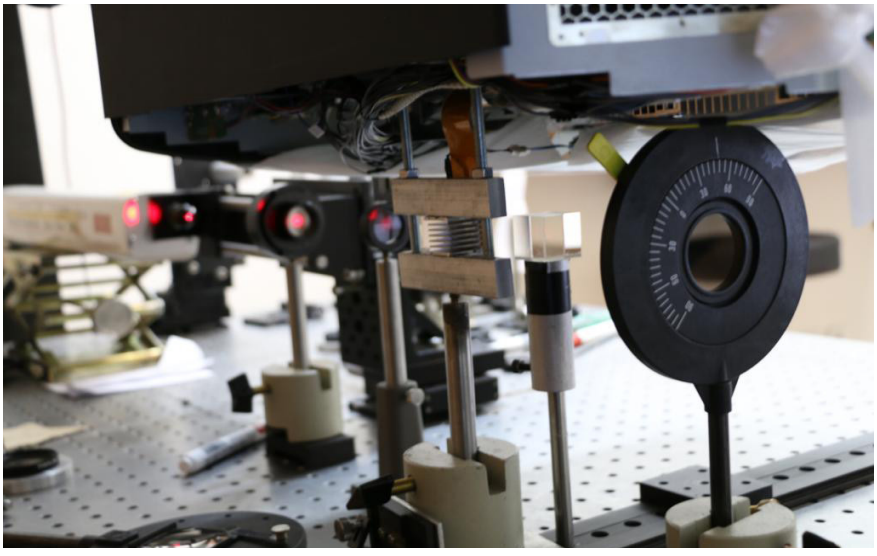
Superconducting Devices & Circuits Laboratory

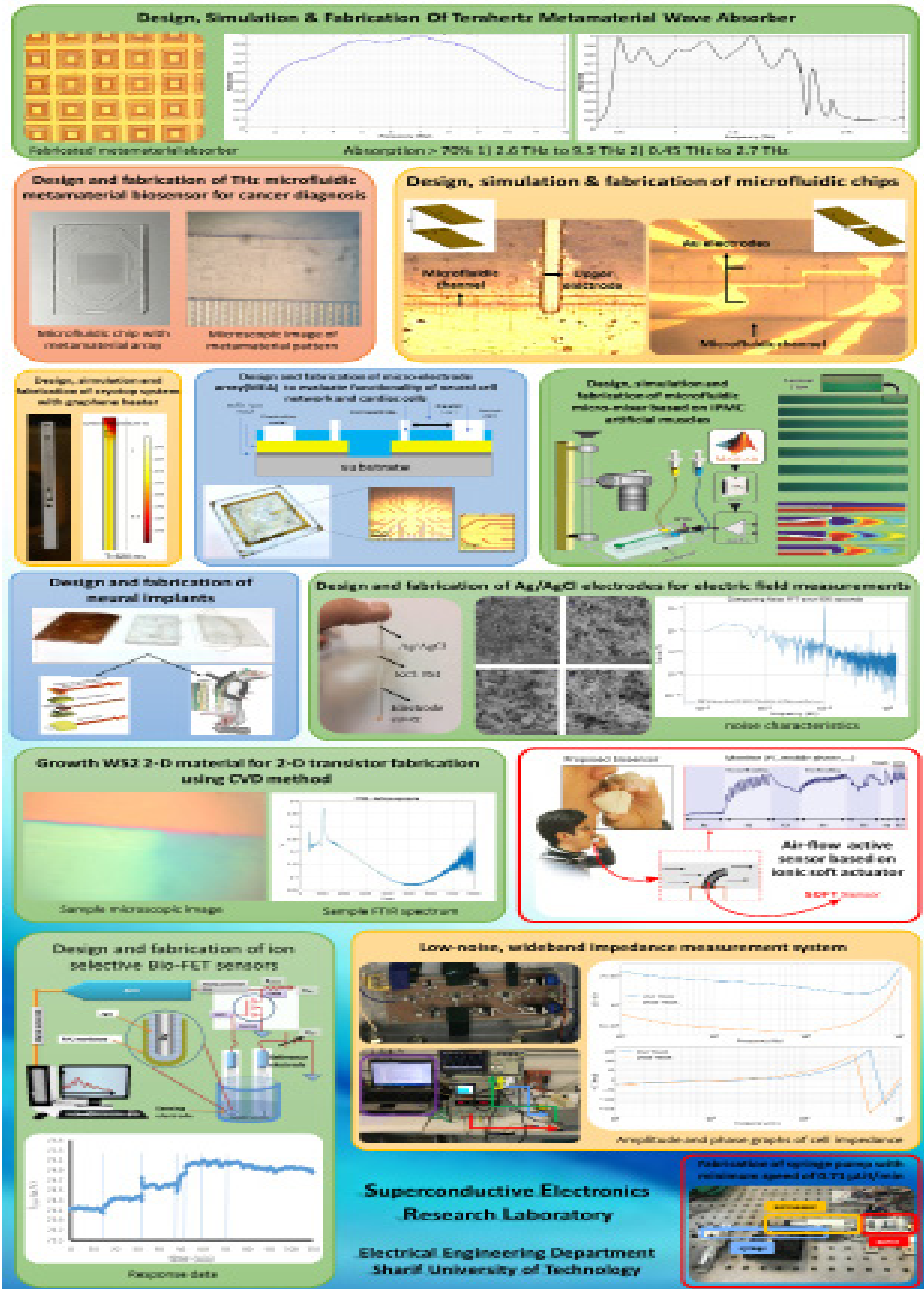
integrity); On-chip low-swing signaling techniques; Network-on-chip systems; More than Moore/beyond CMOS technologies

6. **3D Imaging Lab:** 3D imaging, Millimeter-wave imaging and holography; Biomedical imaging systems; Medical ultrasonic imaging, Photoacoustic imaging, Optical Coherence Tomography (OCT), Computerized Tomography (CT); Optical information processing and optical Super-Computers Based on digital optics and Nonlinear optics; Multi-camera 3D imaging in automatic surveillance systems; Single-pixel imaging; Terahertz technologies



Optics & Terahertz Laboratory-




Design, Simulation & Fabrication Of Terahertz Metamaterial Wave Absorber
Fabricated metamaterial absorber
Absorption > 70% 1) 2.6 THz to 3.5 THz 2) 0.45 THz to 2.7 THz
Design and fabrication of THz microfluidic metamaterial biosensor for cancer diagnosis
Microfluidic chip with metamaterial array
Microscopic image of metamaterial pattern
Design, simulation & fabrication of microfluidic chips
Microfluidic channel
Upper electrode
Au electrodes
Microfluidic channel
Design, simulation and fabrication of cryostat system with graphene heater
Design and fabrication of micro-electrode array(MEA) to measure Functionality of neural cell network and cardiac cells
substrate
Design, simulation and fabrication of microfluidic micro-mixer based on IPMC artificial muscles
Design and fabrication of neural implants
Design and fabrication of Ag/AgCl electrodes for electric field measurements
Ag/AgCl
PDMS film
Electrode area
noise characteristics
Growth WS2 2-D material for 2-D transistor fabrication using CVD method
Sample microscopic image
Sample PL spectrum
Air-flow active sensor based on ionic soft actuator
Design and fabrication of ion selective Bio-FET sensors
Response data
Low-noise, wideband impedance measurement system
Amplitude and phase graphs of cell impedance
Superconductive Electronics Research Laboratory
Electrical Engineering Department
Sharif University of Technology

Electric Energy Systems

General information

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Research Laboratories	Reliability and Distributed Generation Electric Drives and Power Electronics High Voltage research Insulation research Power quality and micro-grid Power Systems Control and Dynamics Power System Modeling & Simulation Power System Research Smart Grid
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Research

Electrical energy systems have witnessed rapid changes in recent years, and even more changes are expected for near future. Technologically, flexibility in the control of transmission and distribution systems has been sought through power electronic switches and converters. Renewable energy sources like photovoltaics and wind turbines are growing very quickly and penetrating the electric grids both in the form of large generating plants and small to medium dispersed generators connected to distribution networks. On the other hand, proliferation of

modern loads like electronic appliances, converter-based drives and electric vehicles are creating new challenges for the grid.

With respect to power management, most power systems have been restructured in recent years to provide open access to the system for all energy providers and trading entities in a competitive market place. System reliability and electric power quality are now of prime importance. To address these challenges, the future smart grids will rely on advanced infrastructures like wide area measurement and control systems and data communication networks, as well as grid-connected and autonomous microgrids, which might be ac, dc or hybrid.

Research in the Power Engineering group covers a wide spectrum of subjects with a particular focus on the fundamental R&D needs of Iranian electric power and energy industry. Our academic staff has been involved in a variety of industrial research projects from different Iranian national utility (Electric Distribution/ Regional Electric) companies, Tavanir Company, Iran Energy Efficiency Organization (IEEO-SABA), Tehran Urban & Suburban Railway Operation Co, gas and petroleum refineries, and private sector companies active in manufacturing of transformers, electric machines, and protection relays. Moreover, the group accommodates the Centre of Excellence for Power System Management & Control (CEPS-MC), one of the three national centers of excellence in the department.

Reliability and Distributed Generation (RDG)

Reliability modeling, as well as reliable planning and operation of power systems and their components are essential ingredients in generation, transmission, and distribution of electric power. The RDG lab focuses on these aspects. Due to its long-standing association with the power industry, RDGL has an appreciation of the technical challenges facing power grids, and can help the power industry to address problems associated with integration of RE and DG technologies. Moreover, the lab provides advice on reliability-centered maintenance for electric power generation & transmission sectors, and performance-based regulation for power distribution companies. On the planning side, the lab has extensive experience in reliability analysis, critical component detection, and performance evaluation. It also helps design a future architecture for power industry that is based on highly efficient, low impact energy sources and technologies.

Smart Grids

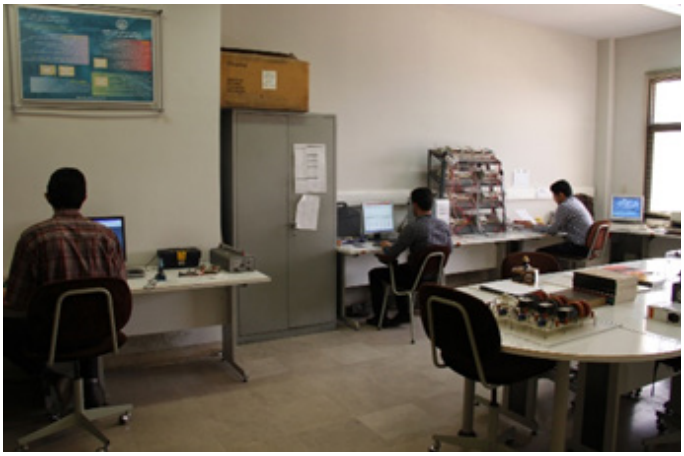
The Smart Grid Laboratory aims to develop innovative models to study the emerging smart grid technologies and optimally integrate them into the system planning and operation frameworks. The research activities of

the laboratory span a broad range of topics including demand-side management, integration of renewable energy resources, integration of electricity storage systems, proliferation of electric and hybrid electric vehicles, distribution automation, plug-in hybrid electric vehicle (PHEV), and cyber security and privacy. In addition, the Smart Grid Laboratory supports Iranian electric power industry in its ongoing modernization of the nation's electric grid. The laboratory is currently active in a number of industrial projects such as load commitment in smart homes, and

feasibility study of PHEVs and their impact on distribution system demand-side management.

Power Quality & Microgrids (PQM)

The PQM lab is the country's leading lab in power quality research. Equipped with up-to-date professional instruments, PQM lab carries out various fundamental and applied projects including harmonic estimation and load flow, power quality disturbance detection and classification, nonlinear load modeling, and novel power quality/



energy monitoring and management systems. Another major activity of PQM lab involves the recently emerging field of micro grids. PQM lab focuses on all aspects of ac, dc, and hybrid microgrids, including power sharing issues in presence of nonlinear and imbalanced loads, and grid-connected and islanded modes of operation.

Electric Drives and Power Electronics (EDPEL)

EDPEL carries out theoretical and experimental research in different fields of power electronics and electric drives. The lab is well equipped with different measurement instruments as well as FPGA- and DSP-based boards and DC and AC power supplies. While general issues of the subject have been covered since its foundation in 1998, in recent years, highly reliable converters and fault tolerant high power converters are the main active subjects of EDPEL. EDPEL is actively involved in industrial projects like using Super-capacitors as regenerative breaking storage system, and variable speed drives for efficiency im-

provement of the pumps in gas and petroleum refinery companies.

Among other research fields of the group are insulation aging and partial discharge, wireless power transfer, pulse power, stability analysis and improvement of power system.

International Cooperation

The Power Engineering group has been involved in many international research activities through collaborative research projects, Ph.D. student exchange and co-supervision programs with a number of universities including:

Aalborg University, Denmark
Aalto University, Finland
Illinois Institute of Technology, USA
University of Toronto, Canada
University of British Columbia, Canada
University of Lorraine, France
University of New South Wales, Australia
University of Saskatchewan, Canada
Universidad Técnica Federico Santa María, Chile
University of New Brunswick, Canada
Universiti Teknologi Mara (UiTM), Shah Alam, Selangor, Malaysia

Microwaves and Photonics

General information

Director	Behzad Rejaei
Academic Staff	Mahmood Akbari Ali Banaei Mehdi Ahmadi-Boroujeni Forouhar Farzaneh Amin Khavasi Khashayar Mehrany Mohammad Memarian Behzad Rejaei Amir Ahmad Shishegar
Research Laboratories	Microwave and Millimeter Wave Lab. Microwave and Photonic Research Lab. Terahertz and Far-Infrared Lab. Computational Electromagnetics Lab
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Research

At its heart, electromagnetics is the branch of physics which describes the motion and interaction of charged particles. Indeed, up to the early decades of the twentieth century, electromagnetic engineering was hardly discernible from physics. However, things rapidly changed in the course of the last century and the advent of wireless communications, radio and television, radar, satellite communication, and photonics has made electromagnetic engineering a vibrant and indispensable area within electrical engineering. The Microwave and Optical Communications group focuses on diverse aspects of electromagnetic field theory and engineering especially for communication applications.

Microwave circuit synthesis and design forms one of the major research areas within this group. As a highly dynamic discipline within microwave engineering, it focuses on the design and implementation of microwave filters, multiplexers, phased locked loops, inter injection locked oscillators. Design and analysis of linear and nonlinear microwave circuits and phase-noise measurement of microwave oscillators are other examples of currently running investigations in this field. Another related research area in the group is antenna design and configuration for applications such smart antennas and MIMO.

At a more theoretical level, studies are also performed on analytical and computational electromagnetics based on Green's function techniques. Asymptotic methods are also explored, in particular for indoor/outdoor propaga-

tion modeling and scattering analysis.

Study of optical and plasmonic devices constitutes another line of research in the Microwave and Optical Communications group. Research is carried out on optical devices such as lasers, optical sensors and photovoltaics, and circuit modeling of photonic structures especially periodic structures. Plasmonic devices and circuits are also explored. Examples include the development of circuit models for conventional plasmonic waveguides and junctions, and study of Graphene-based plasmonic waveguides and absorbers.

Finally, attention is paid to THz engineering with particular emphasis on generation and propagation of millimeter- and THz waves, as well as related applications such as imaging.

Communication Circuits Laboratory

Centers of Excellence

Multi-Access Communication Systems

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Website	

Starting in the year 2000 as one of the first Centers of Excellence (CoE) in the country, the center of excellence for Multi-Access Communication Systems has successfully initiated research in wide areas of communications from fields and waves, to optical and system level designs. Its vision for coming years is to become even more active in fundamental and practical research in key topics such as next generation mobile network development under 5G research platform, covering physical to MAC and network layer initiatives. This center is also privileged to host the top highly-cited researchers and two of the three IEEE Fellows in the whole country. The CoE for Multi-Access Communication Systems was selected as the best CoE in the whole country among all engineering centers in the year 2013, further stressing the level of its research at the national level.

This center consists of the following laboratories:

Optical Multi-Access Systems (Prof. Salehi)
Mobile Communications (Prof. Nasiri)
Signal Processing & Multimedia (Prof. Marvasti)
Communication Systems (Prof. Khalaj)
High Frequency Devices (Prof. Rejaei and Mehrany)

Power System Management & Control

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This center was founded in part to respond to the fundamental R&D needs of the Iranian power industry, and to carry out state of the art research on management and control of generation, transmission and distribution of electricity in a classical or restructured power-system and market operation. Another objective is to develop the necessary background to raise collaboration among talented researchers and experts in the field, including graduate students, professors and industrial experts. Finally, the CoE aims to provide technical and advisory services to public and private organizations that are active in the area of operation, planning, design and management of electric power systems with emphasis on Micro grids, Renewable Resources, and smart Grids.

Encouragement and support of young researchers, initiation of research through identification of demands by the national power industry, and synchronization of its position with international developments are among other major goals of this CoE.

New Set of Research Groups

Design and production of knowledge-based products constitute important areas of research activities in the Faculty of Electrical Engineering of Sharif University of Technology. Faculty members take steps to develop knowledge-based products by forming various student teams in various fields of electrical engineering and concluding appropriate industry-related contracts. This upward movement, while creating self-sufficiency in many technology-based fields, provides employment for the young generation of scientists in the country and is one of the most effective strategies to combat brain drain.

Some of the products developed are listed below:

1. Digital health products; Such as vital signs smart wristband, heart rate monitor and terahertz 3D imaging device
2. Telecommunication system products; Automotive radar, fifth generation telecommunication transceiver communication kit, molecular telecommunication laboratory kit
3. Power electronics products; Electric vehicle power generation machine, Rizalor machine for all types of electric motors.

Smart Vital Signs Wristband

Electric Motor Advanced Resolvers

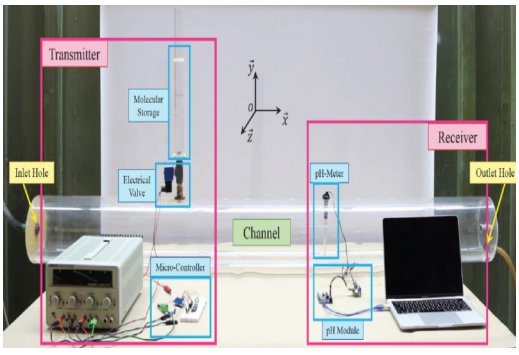
3D terahertz imaging device

Electric Vehicle Power Generation Unit

5G signal receiver board

Automotive Radar Unit

heart rate monitor



Molecular Communication Laboratory Sample

DEPARTMENT OF

ELECTRICAL ENGINEERING

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