COMSATS University Islamabad
Registrar Office, Academic Unit (PS)

No: CUI-Reg/Notif- 432 /24/ 446 February 22, 2024

NOTIFICATION

Academic Council in its 38th meeting held on January 09, 2024, on the recommendations of 33rd meeting of Board of Faculty of Engineering, approved following revised Scheme of Studies of Bachelor of Science in Computer Engineering (BSCE) effective from Fall 2023 as per HEC Undergraduate Education Policy, 2023:

1. Name of Degree: Bachelor of Science in Computer Engineering (BSCE)

Minimum Duration:	04 Years	Minimum Semesters:	08	Minimum Credit Hours required:	133

2. Framework of Courses and Credit Hours for Degree Program

Sr. No	Course Work	(Min No. of Courses)	(Min No. of Credit Hours)
a)	General Education Courses	12	30
b)	Major Engineering Discipline Courses		
	1. Computer and Information Sciences	02	08
	2. Engineering Foundation Courses	08	28
	3. Core Breadth Courses	07	22
	4. Core Depth Courses	06	21
	5. Multi-Disciplinary Engineering Courses	02	06
c)	Interdisciplinary/Allied Courses	04	12
d)	Field Experience/Internship	01	0
e)	Capstone Project	02	06
Minimum No. of Courses required:		**44**	
Minimum No. of Credit hours required:			**133**

Note: Common policies and procedures notified vide No. CUI-Reg/Notif-1794/23/1884, dated August 25, 2023 relating to Undergraduate Degree Programs approved by the Competent Authority and amended from time to time shall be applicable.

Dr. Muhammad Hanif
Deputy Registrar

Distribution:
1. All Directors, CUI
2. All Deans, CUI
3. Incharge Islamabad Campus, CUI
4. Controller of Examinations, CUI
5. All Chairpersons, CUI
6. All HoDs/Incharge of Academics/Examinations Sections, CUI Campuses
7. Internal distributions, Registrar Office, CUI

CC:
1. PS to Rector CUI
2. PS to Registrar CUI

A. General Education Courses

i. Arts and Humanities (any one course from the following list)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM107	21st Century Communication Skills	2(2, 0)	
2.	HUM310	Islamic History	2(2, 0)	
3.	ADA111	History and Theory of Art and Culture I	2(2, 0)	
4.	ARC108	Art Appreciation	2(2, 0)	
5.	ARC351	Calligraphic Arts	2(2, 0)	

ii. Natural Sciences (Mandatory Course)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	PHY124	Applied Physics	3(2, 1)	

iii. Social Sciences (Mandatory Course)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	ECO290	Fundamentals of Engineering Economics	2(2, 0)	

iv. Functional English (Mandatory Course)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM104	Functional English	3(3, 0)	

v. Expository Writing (Mandatory Course)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM120	Expository Writing	3(3, 0)	

vi. Quantitative Reasoning (any two courses from the following list)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	MTH114	Calculus and Analytic Geometry	3(3, 0)	
2.	MTH231	Linear Algebra	3(3, 0)	
3.	MTH103	Exploring Quantitative Skills	3(3, 0)	
4.	MTH104	Tools for Quantitative Reasoning	3(3, 0)	

vii. **Islamic Studies** will be a mandatory course; however, non-Muslim students will have the option to substitute Islamic Studies with HUM116 Ethics)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM112	Islamic Studies	2(2, 0)	
2.	HUM116	Ethics	2(2, 0)	

viii. **Ideology and Constitution of Pakistan (Mandatory Course)**

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM113	Ideology and Constitution of Pakistan	2(2, 0)	

ix. **Applications of Information and Communication Technologies (Mandatory Course)**

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	CSC101	Applications of Information and Communication Technologies	3(2, 1)	

x. **Entrepreneurship (Mandatory Course)**

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	MGT250	Introduction to Entrepreneurship	2(2, 0)	

xi. **Civics and Community Engagement (Mandatory Course)**

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	HUM208	Civics and Community Engagement	2(2, 0)	

B. Major Engineering Discipline Courses

Knowledge Area	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
Computer and Information Sciences	CSC103	Programming Fundamentals	4(3, 1)	
	CSC241	Object Oriented Programming	4(3, 1)	CSC103
Engineering Foundation	CPE214	Computer-Aided Engineering Design	1(0, 1)	
	CPE122	Linear Circuit Analysis	4(3, 1)	
	CPE241	Digital Logic Design	4(3, 1)	
	CPE231	Electronic Devices and Circuits	4(3, 1)	CPE122
	CPE223	Signals and Systems	4(3, 1)	MTH242
	CPE343	Computer Organization and Architecture	4(3, 1)	CPE241
	CSC211	Data Structures	4(3, 1)	CSC103
	CPE251	Probability Methods in Engineering	3(3, 0)	MTH114
Core Breadth	CPE314	Data Communication and Computer Networks	4(3, 1)	
	CPE342	Microprocessor Systems and Interfacing	4(3, 1)	CPE241
	CSC270	Database Systems	4(3, 1)	
	CSC323	Operating Systems	3(2, 1)	
	CSC291	Software Engineering	3(3, 0)	
	CPE345	Embedded Systems Workshop	1(0, 1)	CSC103, CPE342
	EGG101	Engineering Professionalism	3(3, 0)	
Core Depth	CPE462	Artificial Intelligence	3(2, 1)	CSC103
	CPE324	Digital Signal Processing	4(3, 1)	CPE223
	CPE344	Digital System Design	4(3, 1)	CPE241
		Computer Engineering Depth Elective I	4(3, 1)	
		Computer Engineering Depth Elective II	3(3, 0) / 3(2, 1) / 4(3, 1)	
		Computer Engineering Depth Elective III	3(3, 0) / 3(2, 1) / 4(3, 1)	
Multi-Disciplinary Engineering Electives		Multi-Disciplinary Engineering Electives I	3(3, 0) / 3(2, 1) / 4(3, 1)	
		Multi-Disciplinary Engineering Electives II	3(3, 0) / 3(2, 1) / 4(3, 1)	

i. **Computer Engineering Depth Electives** (any three courses from the following list with at least one course of 4 credit hours)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.	CPE434	VLSI Design	4(3, 1)	CPE241, CPE231
2.	CPE446	Real Time Embedded Systems	4(3, 1)	CPE342
3.	CPE442	Digital and Mixed Signal System Testing and Testable Design	4(3, 1)	CPE241, CSC211
4.	CPE444	Advanced Digital System Design	4(3, 1)	CPE344
5.	CPE441	Hardware-Software Codesign	4(3, 1)	CPE342
6.	CPE440	Computer Architecture	3(3, 0)	CPE343
7.	CPE325	Control Systems	4(3, 1)	CPE223
8.	CPE415	Digital Image Processing	4(3, 1)	CPE223
9.	CPE472	Speech, Image and Video Processing	3(3, 0)	CPE223
10.	CPE447	Robotics	3(3, 0)	CPE325
11.	CPE461	Neural Networks	3(3, 0)	
12.	CSC354	Machine Learning	3(3, 0)	
13.	CSC232	Information Security	3(2, 1)	
14.	CSC334	Parallel and Distributed Computing	3(2, 1)	CSC323
15.	CSC497	Data Warehousing and Data Mining	3(2, 1)	CSC270
16.	CSC495	Game Development	3(2, 1)	CSC241
17.	CPE445	Internet of Things	3(3, 0)	
18.	DSC293	Data Science Fundamentals	3(2, 1)	

ii. **Multi-Disciplinary Engineering Electives** (any two courses from the following list with at least one course of 3 credit hours)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.	EEE351	Principles of Communication Systems	4(3, 1)	EEE223 or CPE223
2.	EEE353	Digital Communication Systems	4(3, 1)	EEE351, CPE251
3.	EEE354	Telecommunication Systems Engineering	3(3, 0)	EEE351
4.	EEE456	Broadband Technologies	3(3, 0)	EEE314 or CPE314
5.	EEE464	Wireless Communication Systems	3(3, 0)	EEE351
6.	EEE371	Electric Machines	4(3, 1)	EEE222 or CPE122
7.	EEE488	Renewable and Alternate Energy Systems	3(3, 0)	
8.	EEE382	Power Generation	3(3, 0)	
9.	EEE375	Power Distribution and Utilization	4(3, 1)	EEE222 or CPE122
10.	EEE232	Electronics II	4(3, 1)	EEE231 or CPE231

11.	EEE333	Analog Integrated Circuits, Analysis and Design	4(3, 1)	EEE231 or CPE231
12.	EEE489	Power Plant Engineering	3(3, 0)	EEE222 or CPE122
13.	CSC336	Web Technologies	3(2, 1)	CSC241
14.	CSC303	Mobile Application Development	3(2, 1)	CSC241

C. List of Interdisciplinary/Allied Courses (Mandatory Courses)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.		Natural Sciences Elective		
2.	MTH211	Discrete Mathematics	3(3, 0)	
3.	MTH242	Differential Equations	3(3, 0)	MTH114
4.	MGT462	Project Planning and Management	3(3, 0)	

D. List of Natural Sciences Electives (any one course from the following list)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.	MTH375	Numerical Computations	3(2, 1)	MTH114, CSC103
2.	MTH105	Multivariable Calculus	3(3, 0)	MTH114
3.	ENV101	Fundamentals of Environmental Sciences	3(3, 0)	
4.	ENV454	Environmental Impact Assessment	3(3, 0)	
5.	MTH374	Optimization	3(3, 0)	MTH114
6.	MTH467	Operations Research	3(3, 0)	MTH114

E. Internship (Mandatory Course)**

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.	EGG497	Internship	3(0, 3)	

F. Capstone Project (Mandatory Courses)

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)[†]
1.	EGG498	Final Year Project (Part I)*	3(0, 3)	
2.	EGG499	Final Year Project (Part II)	3(0, 3)	EGG498 Final Year Project (Part I)

G. Remedial Course***

#	Course Code	Course Title	Credit Hours[1]	Prerequisite(s)†
1.	CHM102	Introduction to Chemistry	3(2, 1)	

Notes:

[1] 03 credit hours of theory is equivalent to 03 hours of lectures whereas 01 credit hour of lab is equivalent to 03 hours of lab session. All the lab sessions are graded. Students have to pass both theory and lab to earn the course credits.

† Courses with prerequisites can only be allowed if all prerequisite courses have been passed.

* Students must pass at least 80 credit hours (engineering and non- engineering subjects) to register for the final year project.

** EGG497 Field Experience/Internship minimum duration 6-8 weeks, preferably conducted in summer breaks after the 4th semester, as a *Non-Credit mandatory requirement* for degree completion.

*** To be offered as a Non-Credit course to the students who have passed FSc/Equivalent with Physics, Mathematics and Computer Studies/Science (ICS) combination, i.e., FSc/Equivalent with non-Pre-Engineering background. These students may preferably pass this remedial course during the 1st year of their degree program. This course will not contribute to student's GPA.

Bachelor of Science in Computer Engineering Degree with One Major and Additional Minors

A student may opt for the degree with single major and either one or two additional minors, subject to fulfilling the following conditions for the opted minors:

a) A student is required to complete a minimum of 12 credit hours from the same minor cluster to earn the additional minor.

b) A course from a minor cluster cannot be registered if the same course is already studied in degree major.

c) To register for a course in a minor cluster, any required pre-requisite course which is not listed in minor table, should be completed as non-credit course, if not studied in degree major.

d) With the consent of the Head of Department, any other course from the domain of Electrical/Computer Engineering or Computer Science, for which prerequisite courses and above-mentioned conditions are satisfied, can also be offered as a minor course.

e) The Regulations relating to degree minors approved by the Competent Authority and amended from time to time shall be applicable.

Additional Notes:

1. Students enrolled in the **Bachelor of Science in Computer Engineering** program have the flexibility to choose to pursue one or two additional minors or even opt for a second major as per the scenarios stated below. These minors and majors can be selected from any category of courses recognized as minors or majors by other programs offered at their respective CUI campus. This choice must adhere to the established rules and regulations of the University.

   a) **Scenario 1 - Single Major (Min. 133 credits):**
   This scenario centers on a single major, demanding a minimum of 133 credits for completion. This breakdown includes 30 credits for general education, a minimum of 85 credits for the major discipline courses, 12 credits for interdisciplinary studies and 6 credits for the capstone project.

   b) **Scenario 2 - Single Major with Minor (Min. 145 credits):**
   In this case, a single major is accompanied by a minor, requiring a minimum of 145 credits in total. This breakdown includes 30 credits for general education, a minimum of 85 credits for the major discipline courses, 12 credits for interdisciplinary studies and 6 credits for the capstone project. Additionally, a 12-credit minor complements the major, fostering broader skills.

   c) **Scenario 3 - Single Major with Two Minors (Min. 157 credits):**
   Here, a single major is augmented by two minors, totaling a minimum of 157 credits. This breakdown includes 30 credits for general education, 85 for the major, 12 for interdisciplinary studies, 6 for the capstone project and two minors with a minimum of 12 credits each.

   d) **Scenario 4 - Double Major (Min. 205 credits):**
   This scenario involves pursuing two majors, necessitating a minimum of 205 credits. This breakdown includes 30 credits for general education, a minimum of 85 credits for the first major, minimum 72 credits for second major, 12 for interdisciplinary studies and 6 for the capstone project.

2. The study of the Holy Quran and teachings of Sirat un-Nabi (P.B.U.H) courses will constitute a mandatory component of the curriculum for all undergraduate degree programs. These courses will be conducted using a hybrid mode of instruction across the CUI System. Upon successful completion of each course, students will receive a certificate endorsed by the Head of Department (HoD). Additionally, the accomplishment of these courses will be indicated separately on the final transcripts as mandatory noncredit courses.

Bachelor of Science in Computer Engineering
Tentative Plan of Studies

The course offering in each semester as given below is not fixed. It may vary depending on the availability of faculty and needs of the student.

Semester – 1

Course Code	Course Title	Credit Hours	Prerequisite(s)
HUM104	Functional English	3(3, 0)	
HUM112	Islamic Studies	2(2, 0)	
MTH114	Calculus and Analytic Geometry	3(3, 0)	
PHY124	Applied Physics	3(2, 1)	
CSC101	Applications of Information and Communication Technologies	3(2, 1)	
CPE122	Linear Circuit Analysis	4(3, 1)	
	Total Credit Hours	**18(15, 3)**	

Semester – 2

Course Code	Course Title	Credit Hours	Prerequisite(s)
HUM113	Ideology and Constitution of Pakistan	2(2, 0)	
MTH211	Discrete Mathematics	3(3, 0)	
MTH231	Linear Algebra	3(3, 0)	
CPE214	Computer-Aided Engineering Design	1(0, 1)	
CSC103	Programming Fundamentals	4(3, 1)	
CPE231	Electronic Devices and Circuits	4(3, 1)	CPE122
	Total Credit Hours	**17(14, 3)**	

Semester – 3

Course Code	Course Title	Credit Hours	Prerequisite(s)
MTH242	Differential Equations	3(3, 0)	MTH114
CSC291	Software Engineering	3(3, 0)	
CSC241	Object Oriented Programming	4(3, 1)	CSC103
CPE241	Digital Logic Design	4(3, 1)	
EGG101	Engineering Professionalism	3(3, 0)	
	Total Credit Hours	**17(15, 2)**	

Semester – 4

Course Code	Course Title	Credit Hours	Prerequisite(s)
CPE251	Probability Methods in Engineering	3(3, 0)	MTH114
CPE223	Signals and Systems	4(3, 1)	MTH242
CSC211	Data Structures	4(3, 1)	CSC103
CSC270	Database Systems	4(3, 1)	
ECO290	Fundamentals of Engineering Economics	2(2, 0)	
	Total Credit Hours	**17(14, 3)**	

Semester – 5

Course Code	Course Title	Credit Hours	Prerequisite(s)
	Natural Sciences Elective	3(2, 1)/3(3, 0)	
CPE343	Computer Organization and Architecture	4(3, 1)	CPE241
CPE324	Digital Signal Processing	4(3, 1)	CPE223
CSC323	Operating Systems	3(2, 1)	
CPE342	Microprocessor Systems and Interfacing	4(3, 1)	CPE241
	Total Credit Hours	**18(13-14, 4-5)**	

Semester – 6

Course Code	Course Title	Credit Hours	Prerequisite(s)
CPE344	Digital System Design	4(3, 1)	CPE241
CPE314	Data Communication and Computer Networks	4(3, 1)	
CPE462	Artificial Intelligence	3(2, 1)	CSC103
HUM120	Expository Writing	3(3, 0)	
	Computer Engineering Depth Elective I	4(3, 1)	
	Total Credit Hours	**18(14, 4)**	

Semester – 7

Course Code	Course Title	Credit Hours	Prerequisite(s)
HUM208	Civics and Community Engagement	2(2, 0)	
MGT462	Project Planning and Management	3(3, 0)	
CPE345	Embedded Systems Workshop	1(0, 1)	CSC103, CPE342
EGG498	Final Year Project (Part I)	3(0, 3)	
	Computer Engineering Depth Elective II	3(3, 0)/4(3, 1) /3(2, 1)	
	Multi-Disciplinary Engineering Elective I	3(3, 0)/3(2, 1)	
	Total Credit Hours	**15-16(9-11, 4-6)**	

Semester – 8

Course Code	Course Title	Credit Hours	Prerequisite(s) †
	Arts and Humanities Elective	2(2, 0)	
MGT250	Introduction to Entrepreneurship	2(2, 0)	
EGG499	Final Year Project (Part II)	3(0, 3)	EGG498
	Computer Engineering Depth Elective III	3(3, 0)/4(3, 1) /3(2, 1)	
	Multi-Disciplinary Engineering Elective II	3(3, 0)/4(3, 1) /3(2, 1)	
	Total Credit Hours	**13-15(8-10, 3-5)**	

Framework of BS Computer Engineering Program

Duration:	4 years
Number of semesters:	8
Number of weeks per semester:	16 - 18 (16 for teaching and 2 for examinations)
Total number of credit hours:	133-136
Engineering Courses:	68.4-69.1%
Non-Engineering Courses:	30.9-31.6%

Summary				
Domain	**Knowledge Area**	**Total Courses**	**Total Credits**	**% Overall**
Non-Engineering	Humanities	8	19	30.9-31.6
	Management Sciences	2	5	
	Natural Sciences	6	18	
	Sub Total	**16**	**42**	
Engineering	Computing	2	8	68.4-69.1
	Engineering Foundation	8	28	
	Major Based Core (Breadth)	7	22	
	Major Based Core (Depth)	6	21-23	
	Multi-Disciplinary Engineering Courses	2	6-7	
	Final Year Design Project	2	6	
	Internship	1	0	
	Sub Total	**28**	**91-94**	
	Grand Total	**44**	**133-136**	**100%**

Non-Engineering Domain						
Knowledge Profile	**Knowledge Area**	**Sub- Area**	**Course**	**Cr. Hrs.**	**Total Credits**	**% Overall**
WK-7	Humanities	English	Functional English	3(3, 0)	19	14.0-14.3
			Expository Writing	3(3, 0)		
		Culture	Islamic Studies/Ethics	2(2, 0)		
			Ideology and Constitution of Pakistan	2(2, 0)		
			21st Century Communication Skills	2(2, 0)		
		Social Science	Civics and Community Engagement	2(2, 0)		
			Applications of ICT	3(2, 1)		
			Fundamentals of Engineering Economics	2(2, 0)		
	Management Sciences	Professional Practice	Project Planning and Management	3(3, 0)	5	3.7-3.8
			Introduction to Entrepreneurship	2(2, 0)		
WK-2	Natural Science	Math	Calculus and Analytic Geometry	3(3, 0)	12	8.8-9.0
			Linear Algebra	3(3, 0)		
			Differential Equations	3(3, 0)		
			Discrete Mathematics	3(3, 0)		
WK-1		Natural Science (physics, chemistry math)	Applied Physics	3(2, 1)	6	4.4-4.5
			Natural Sciences Elective	3(3, 0)		
Total (Non-Engineering) Credit Hours					**42**	**30.9-31.6**

Engineering Domain						
Knowledge Profile	**Knowledge Area**	**Sub Area**	**Course**	**Cr. Hrs.**	**Total Credits**	**% Overall**
WK-2/WK-4/WK-5/WK-6	Computer and Information Sciences	AI/Data Science/Cyber Security	Programming Fundamentals	4(3, 1)	8	5.9-6.0
			Object Oriented Programming	4(3, 1)		
WK-3/WK-2	Foundation Engg Courses		Computer-Aided Engineering Design	1(0, 1)	28	20.6-21.0
			Linear Circuit Analysis	4(3, 1)		
			Digital Logic Design	4(3, 1)		
			Electronic Devices and Circuits	4(3, 1)		
			Signals and Systems	4(3, 1)		
			Computer Organization and Architecture	4(3, 1)		
			Data Structures	4(3, 1)		
			Probability Methods in Engineering	3(3, 0)		
WK-4/WK-2/WK-1	Core Breadth of Engg Discipline		Data Communication and Computer Networks	4(3, 1)	22	16.2-16.5
			Microprocessor Systems and Interfacing	4(3, 1)		
			Database Systems	4(3, 1)		
			Operating Systems	3(2, 1)		
			Software Engineering	3(3, 0)		
			Embedded Systems Workshop	1(0, 1)		
			Engineering Professionalism	3(3, 0)		
WK-5/WK-6/	Core Depth of Engg Discipline		Artificial Intelligence	3(2, 1)	21-23	15.8-16.9
			Digital System Design	4(3, 1)		
			Digital Signal Processing	4(3, 1)		
			Computer Engineering Depth Elective I	4(3, 1)		
			Computer Engineering Depth Elective II	3(3, 0) /4(3, 1)/ 3(2, 1)		
			Computer Engineering Depth Elective III	3(3, 0) /4(3, 1)/ 3(2, 1)		

WK-3/WK-4/WK-2/WK-1	Multidisciplinary Engg Courses		Multi-Disciplinary Engineering Elective I	3(3, 0)/ 3(2, 1)	6-7	4.5-5.1
			Multi-Disciplinary Engineering Elective II	3(3, 0) /4(3, 1)/ 3(2, 1)		
WK-6/WK-8/WK-7	Final Year Design Project (FYDP)/ Capstone		Final Year Project (Part I)	3(0, 3)	6	4.4-4.5
			Final Year Project (Part II)	3(0, 3)		
WK-6/WK-7	Industrial Training		Internship	0(0, 0)	0	
Total (Engineering) Credit Hours					**91-94**	**68.4-69.1**
Total Credit hours					**133-136**	

COURSE CONTENTS

Course Code: MTH375
Course Title: Numerical Computations
Credit Hours: 3(2, 1)
Pre-requisite(s): MTH114, CSC103

Course Objectives:
The primary objective of this course is to introduce students to the basic concepts and terminologies used in Numerical Computations. Students will also learn to implement numerical methods using modern software tools.

Course Outline:
In this course, the students will learn the concept of root finding for nonlinear equations, finding solutions of linear systems, interpolation, and approximation of functions by simple computational building blocks (polynomials and splines), numerical differentiation and divided differences, numerical quadrature, and integration. An important component of numerical analysis is the computational implementation of algorithms developed to observe the issues of accuracy, computational work effort, and stability. The exercises will also include computational experiments.

Recommended Textbook(s):

1. Numerical Analysis by Richard L. Burden, J. Douglas Faires 9th Edition

Reference Book(s):

1. Numerical Methods for Scientists and Engineers by Steven C. Chapra & Raymond Canale.
2. Numerical Methods in Engineering by Jaan Kiusalaas
3. A Primer on Scientific Programming with Python by Hans Petter Langtangen
4. Programming for Computations – Python Timothy J. Barth, Michael Griebel, David E. Keyes, Risto M. Nieminen, Dirk Roose, Tamar Schlick

Course Code: **CPE231**
Course Title: **Electronic Devices and Circuits**
Credit Hours: **4(3, 1)**
Pre-requisite(s): **CPE122**

Course Objectives:
The objective of this course is to teach the principles, operations and characteristics of various electronic devices and their applications in electronic circuits.

Course Outline:
Introduction to Semiconductor Materials, Energy levels, Intrinsic Materials, Doping, Extrinsic Materials, N-Type and P-Type, Semiconductor Diode, Biasing, Characteristic Curve, Load Line Analysis, Diode Approximations, Series and Parallel Configurations, Half-Wave/Full-Wave Rectifiers, Clippers and Clampers, LED, Zener Diode Applications, Construction and Operation of DC biasing, MOSFET – Structure and physical operation, device operation, DC biasing, design using DC biasing, Different Configuration, Small signal models and analysis BJT – Structure and physical operation, Biasing and DC analysis and design, Different Configuration, Small signal models and analysis Introduction to Power Amplifiers, Differential Amplifiers, Operational Amplifiers and Applications

Recommended Textbook(s):

1. Electronic Devices and Circuit Theory by Robert L. Boylestad & Louis Nashelsky, 11th Edition, Pearson
2. Microelectronic Circuits by Adel S. Sedra and Kenneth C. Smith, 6th Edition, Oxford University Press

Reference Book(s):

1. Electronic Devices (Conventional Current Version) By Thomas Floyd, 10th Edition, Pearson
2. Electronic Devices and Circuits by Theodore F. Bogart, Jeffrey S. Beasley and Guillermo Rico, 6th Edition, Pearson
3. Schaum's Outline of Electronic Devices and Circuits by Jimmie J. Cathey, 6th Edition, McGraw-Hill

Course Code: **CPE241**
Course Title: **Digital Logic Design**
Credit Hours: **4(3, 1)**
Pre-requisite(s): **Nil**

Course Objectives:

This is a basic course which concentrates on the basic methods of digital hardware designing. The students will learn different techniques to design simple to moderate level digital hardware. The course contains extensive lab work, in which students will learn to design at IC level. Students will also learn to design basic building blocks of digital logic using hardware descriptive language (Verilog/VHDL).

Course Outline:

Introduction to Digital Computer and Systems, Number Systems, Binary Arithmetic, Boolean Algebra, Algebraic Manipulation, Canonical and Standard Form & Conversions, Logical operations and Gates, Simplification of Functions, Karnaugh Map Methods, Two Level Implementations, Don't Care Conditions, Prime Implicants, Combinational Logic Design, Arithmetic Operations and Circuits, Analysis Procedures, Multilevel NAND/NOR Circuits, Decoders, Encoders, Multiplexers, Demultiplexers, Sequential Logic, Flip-Flops, Clocked Sequential Circuits, State Machine Concept, Design of Sequential Circuits using State Machines, Counters and their Design, Synchronous Counters, Asynchronous Counters, Register, Shift Registers, Universal shift register, Introduction to Programmable Logic architectures (e.g., PAL, PLA, CPLD, FPGAs). Introduction of hardware descriptive language (Verilog/VHDL) and its abstraction levels to design combinational and sequential circuits and their implementation on FPGAs.

Recommended Books:

Textbook:

1. M. Morris Mano and Michael D. Ciletti, Digital Design: With an Introduction to Verilog HDL, Fifth Edition, Prentice Hall, 2012.
2. Digital Design with RTL Design, VHDL, and Verilog by Frank Vahid, Second Edition, John Wiley, 2011

Reference Books:

1. Verilog HDL-A guide to digital design and synthesis by Samir Palnitkar, 2nd Edition, Pearson Education.
2. Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, Third Edition, McGraw-Hill, 2013.

Course Code: **CPE325**
Course Title: **Control Systems**
Credit Hours: **4(3, 1)**
Pre-requisite(s): **CPE223**

Course Objectives:

This course familiarizes students with the basic concepts of control systems. This module is intended to lay a foundation for designing advanced control systems. The students in this course will learn time-domain and frequency-domain methods for the analysis, modeling and design of continuous-time control systems.

Course Description:

Introduction, examples of everyday control system, definition and classification, open loop and closed loop control system. Laplace Transformation- Definition, Laplace Transformation of common signals in time domain, Inverse Laplace Transform, Laplace Theorems, Examples and solution of ordinary differential equations employing Laplace transforms. Identification of systems, Mathematical modeling by physical laws, Modeling of Mechanical systems, Electrical and Electronic systems, Electromechanical systems, Hydraulic systems, and dynamic systems. Block diagrams reduction Techniques, Signal flow graphs, Mason's gain rule. Impulse and Step response along with Time response 1^{st} and 2^{nd} order systems, Calculation of overshoot, undershoot, time constant, rise time, peak time, settling time etc. Steady state errors, positional, velocity and acceleration error constants. Routh-Hurwitz criterion for stability.

PID controllers, effect on the performance of control systems by individual elements of PID controllers. Introduction to design using root locus method and analysis. Frequency domain analysis, Bode analysis, Technique of drawing Bode plot. Phase margin, Gain margins and Design using Bode plots. Introduction to Nyquist analysis, complex analysis, Encirclement and Introduction to Nyquist analysis, complex analysis, Encirclement and enclosure of poles and zeros, Principle of Argument. Stability analysis, Gain margins and phase margins. State space, Introduction to state space analysis of systems presented by Transfer function. Controllability and Observability. Solution of Time invariant state equations.

Recommended Books:

Textbook:

1. Norman S. Nise. Control systems Engineering 4th edition.

Reference Books:

1. Katsuhiko Ogata. Modern Control Engineering 5th edition.
2. Richard C. Dorf. Modern Control System 12th edition.
3. Feedback Control of Dynamic Systems, 6^{th} Edition, Gene F. Franklin, J. David Powell and Abbas Emami-Naeini

Course Code: CPE342
Course Title: Microprocessor Systems and Interfacing
Credit Hours: 4(3, 1)
Pre-requisite(s): CPE241

Course Objectives:

The main objective of this course is to develop an understanding of microprocessor and microcontroller-based systems and their applications. This includes enabling a student to design and use microprocessor-based systems for a variety of purposes such as control, telemetry, digital systems etc. The course focuses on the study of microprocessors and microcontrollers; and their basic support components including architecture, memory interfaces, processor bus concepts, serial I/O devices, and interrupt control devices. Laboratories directly related to microprocessor/microcontroller functions and their interfaces.

Course Description:

Introduction to Microprocessors and Microcontrollers, Overview of a Microprocessor Family, Microprocessor Architecture and Programming, Hardware Specifications, Data Formats & Arithmetic Operations, Instruction Set Summary, Assembly Language Programming, Addressing Modes, Memory Interface, Basic I/O interface, Serial and Parallel Interfacing, Polling and Interrupts, Counters and Interval Timers, A/D and D/A Conversion, Microprocessor Programming and Microprocessor Based System Design, Implementing & Testing the Design.

Recommended Books:

Textbook:

1. "AVR Microcontroller and Embedded Systems: Using Assembly and C", by Muhammad Ali Mazidi
2. "Microcontrollers Fundamentals for Engineers and Scientists", by Steven F. Barrett, Daniel J. Pack Morgan and Claypool.

Reference Books:

1. "Atmel AVR Microcontroller Primer: Programming and Interfacing" by Steven F. Barrett, Daniel J. Pack. Morgan and Claypool, 2007.
2. Atmel AVR Instruction Set Manual.
3. Atmega328p Datasheet

Course Code: **CPE344**
Course Title: **Digital System Design**
Credit Hours: **4(3, 1)**
Pre-requisite(s): **CPE241**

Course Objectives:

This is an introductory course for design of digital systems. The fundamental concepts of digital systems will be examined. It would help in developing expertise to design various arithmetic, logic, memory components, and also able to design register transfer logic (RTL) based digital systems. The practical aspects of digital system design will be covered using hardware descriptive language (Verilog/VHDL). Students will gain hands-on experience on industrial EDA tools for designing and implementing a number of digital systems using FPGAs. Upon successful completion of this course, students would be able to design digital systems and implement digital systems on FPGAs using hardware descriptive language.

Course Description:

Design Process of Digital Hardware, Introduction to FGPA based systems, signed and unsigned numbers, Fixed and floating point numbers, Fast Adders, Multi-operand adders, fast Multipliers, Canonical Signed digits, Synchronous Sequential Circuits, Bus Structure, Finite State Machine design, Algorithmic State Machines (ASM), Memories, Simple Processor, Asynchronous Sequential Circuits, State Reduction, State Assignment, Hazards, Design and Implementation of Register Transfer Logic (RTL) based digital systems, Keyboard controller, VGA Graphics controller, different communication interfaces for digital systems, Industry standard EDA tools for logic description, simulation and synthesis, Verilog/VHDL Behavioral modeling for Combinational and Sequential Circuits, Digital Systems implementation on FPGAs.

Recommended Books:

Textbook:

1. Fundamentals of Digital Logic with Verilog Design by Brown & Vranesic, 2nd Edition.

Reference Books:

1. Verilog HDL-A guide to digital design and synthesis by Samir Palnitkar, 2nd Edition, Pearson Education.
2. Advanced Digital Design with the Verilog HDL by Michael D. Ciletti, Pearson Education.

Course Code: **CPE434**
Course Title: **VLSI Design**
Credit Hours: **4(3, 1)**
Pre-requisite(s): **CPE241, CPE231**

Course Objectives:

The objective of this course is to introduce students to the fundamental concepts of VLSI design and its applications. The course is designed to give the student an in-depth understanding of the different design steps required to carry out a complete digital VLSI (Very-Large-Scale Integration) design in silicon. The design steps starting from behavioral-level modeling to physical layout.

Course Description:

Revision of the Semiconductor Theory, IC Fabrication Methodologies & Processes, Details of MOS Transistors, Fabrication and Analysis of PMOS & NMOS Transistors, Inverters, Resistors, Capacitors, Gates etc., Introduction of VLSI CAD Tools & Simulation Modeling, Implementation of Gates, Mux, Counters, Adders, Multipliers and Memories etc., IC Layout Design Rules, Chip Layout, Design Calculations, Gate and Transistor Level Schematics and their Conversion to Layouts, Dynamic Logic Circuit Concepts and CMOS Dynamic Logic Families: Charge Leakage, charge Sharing, Dynamic RAM Cell, Clocked-CMOS, Pre-Charge/ Evaluate Logic, Domino Logic, Single-Phase Logic. . Issues in Chip Design: ESD Protection, On-Chip Interconnects – Line Parasitics, Modeling of the Interconnect Line, Clock Distribution, Input-Output circuits, Design Optimization, Interconnects, Minimization of Die Area & Power and Maximization of Speed, Modeling Chips using FPGAs.

Recommended Books:

Textbook:

1. Introduction to VLSI Circuits & Systems, 1st Edition – John P. Uyemura

Reference Books:

1. VLSI Design, 1st Edition – Debaprasad Das
2. CMOS VLSI Design, 4th Edition – Neil H.E Weste and David Money Harris

Course Code: **CPE445**
Course Title: **Internet of Things**
Credit Hours: **3(3, 0)**
Pre-requisite(s): **Nil**

Course Objectives:

The core objective of this course is to develop good understanding of the basic concepts associated with internet of things.

Course Description:

Internet of Things course is all about understanding and then developing solid skills to build Internet of Things (IoT) systems. This is a very hands-on intensive and interactive course. Much of the course material will be delivered using the flipped lectures based model where pre-work will be given to students before they come to sessions. Largely, the sessions are based on hands-on workshops where students will perform different programming and development tasks. A number of devices, platforms and software tools will be introduced throughout the course from different vendors.

For Example: Using the FIT IOT-LAB for development of testbeds for network computer communications. IBM BLUEMIX for Cloud Development. Arduino and Raspberry Pi for building embedded systems. Telos Motes. SDN based IoT. Towards the end of the course, two case studies will be introduced to help students apply acquired knowledge to area of Supply Demand and developing an IoT Ecosystem.

Recommended Books:

Textbook:

1. Fei Hu, Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, 1st Edition, ISBN-13:978-1498723183.
2. Brian Russell, Drew Van Duren, Practical Internet of Things Security, 2016.

Course Code: **EGG101**
Course Title: **Engineering Professionalism**
Credit Hours: **3(3, 0)**
Pre-requisite(s): **Nil**

Course Objectives:

To expose students to ethical, environmental, sustainability and societal issues that engineers often face in the practice of engineering profession. The services provided by engineers require honesty, impartiality, fairness, and equity, and they must be dedicated to the protection of public health, safety, and welfare. Students will be made aware of the design principles of safety and risk trade-offs. Students will identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct. Students will be also made aware of their social responsibility towards environmental protection and provide solution for sustainable development.

Course Outline:

The course includes four modules:

1. Ethical issues in the engineering practice:

The module is designed around the topics that include ethical and moral obligations and rights and responsibilities of engineers in relation to society, employers, colleagues, and clients; ethical issues in engineering design, manufacturing, and operations; ethical issues arising from engineering work etc. Engineers must be dedicated to the protection of public health, safety, and welfare.

2. Occupational Health and Safety

In this module, students will be also made aware of concerns and acceptability of safety and risks involved in engineering design. Students will be introduced to the design principles of safety and risk trade-offs. Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others. To handle Accidents & preparing for emergency response procedures.

3. Environmental and sustainability

In module, students will be also made aware of their social responsibility towards environmental protection and provide solution for sustainable development. Engineers will be encouraged to focus on future engineering designs that cater green technology for the protection of the environment and a sustainable future.

Course Code: **CPE445**
Course Title: **Internet of Things**
Credit Hours: **3(3, 0)**
Pre-requisite(s): **Nil**

Course Objectives:

The core objective of this course is to develop good understanding of the basic concepts associated with internet of things.

Course Description:

Internet of Things course is all about understanding and then developing solid skills to build Internet of Things (IoT) systems. This is a very hands-on intensive and interactive course. Much of the course material will be delivered using the flipped lectures based model where pre-work will be given to students before they come to sessions. Largely, the sessions are based on hands-on workshops where students will perform different programming and development tasks. A number of devices, platforms and software tools will be introduced throughout the course from different vendors.

For Example: Using the FIT IOT-LAB for development of testbeds for network computer communications. IBM BLUEMIX for Cloud Development. Arduino and Raspberry Pi for building embedded systems. Telos Motes. SDN based IoT. Towards the end of the course, two case studies will be introduced to help students apply acquired knowledge to area of Supply Demand and developing an IoT Ecosystem.

Recommended Books:

Textbook:

1. Fei Hu, Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, 1st Edition, ISBN-13:978-1498723183.
2. Brian Russell, Drew Van Duren, Practical Internet of Things Security, 2016.

4. Societal issues

Exploring the human side of engineering is the purpose of this module, which examines the complex interactions between technology and society. It develops a better equipped engineer to deal with societal problem, as well as resourceful engineers with a multidisciplinary outlook and strengths in communication and effective interaction with others.

Recommended Books:

1. Ethics in Engineering by Mike E. Martin. 4th Ed (2005)
2. Engineers and their Profession, 4th Ed by J. D. Kemper, NY Saunder, 1990
3. Educating Ethical Engineers by W. Sweet, IEEE Spectrum, Vol. 36 No 6, pp 51-62, June, 1998.
4. NSPE/IEEE Code of Ethics/EMS 14001 Standard/ OHSAS 18001(Specification) and OHSAS18002 (Guideline)
5. The A-Z of health and safety by Jeremy Stranks, 2006.
6. The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.
7. Occupational Safety and Health Law Handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

Course Title: **Linear Circuit Analysis**
Credit Hours: **4(3, 1)**
Course Code: **CPE122**
Pre-requisite: **Nil**

Course outline:

- Electric quantities, electric signals, electric circuits.
- Kirchhoff's laws, circuit elements. Resistance, series parallel combination, voltage and current dividers, resistive bridges.
- Nodal analysis, loop analysis, linearity and superposition, source transformation, one ports, circuit theorems, power calculations. dependent sources, circuit analysis with dependent sources.
- The operational amplifier, basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types.
- Capacitance, inductance (including mutual inductance), natural response of RC and RL circuits. Response to DC forcing function.
- AC fundamentals; RMS or effective, average and maximum values of current & voltage for sinusoidal signal waveforms.

Recommended books:

1. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).

2. R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009

3. C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw- Hill, 4th Edition, 2008

4. J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008

5. W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw- Hill, 7th Edition, 2007.

Course Code: **CPE461**
Course Title: **Neural Networks**
Credit Hours: **3(3, 0)**
Pre-requisite(s): **Nil**

Course Objectives:

To understand the fundamentals of neural networks, their working, optimization, popular models, and application case-studies.

Course Outline:

Neural Networks is a comprehensive course that will provide students with a solid foundation in the field of shallow and deep neural networks and their applications in practical contexts. The course will cover various topics, starting with the fundamentals of machine learning, followed by a detailed look into the basic components of a neural network, including neurons, single and multi-layer networks, multi-class models, activation functions etc., Students will further learn about forward propagation algorithms, loss functions, gradient descent, and backpropagation to train different types of networks. Some industry standard optimization algorithms, approaches to hyper parameter tuning, deep network generalization techniques, transfer learning, data preparation and model evaluation will also be covered thereafter. Moreover, the fundamentals of Convolutional Neural Networks (CNNs) and Recurrent Neural Networks (RNNs) will be explored in some detail, helping students understand their importance in computer vision and sequential data modeling, respectively. Last, but not the least, some seminal neural networks will be presented as detailed case-studies (including Le Net, Alex Net, VGG, ResNet, U-Net and LSTM, to name a few).
Recommended Books:

1. "Neural Networks and Deep Learning, a Textbook", by Charu C. Aggarwal, 2018 (ISBN 978-3-319-94462-3)
2. "Fundamentals of Deep Learning" by Nikhil Buduma, 2nd Edition, 2017 (ISBN 978-1-491-92561-4)
3. "Deep Learning: Adaptive Computation and Machine Learning", by Ian Goodfellow et al., 2016 (ISBN 10: 0262035618)
4. "Applied Deep Learning A Case-Based Approach to Understanding Deep Neural Networks", by Umberto Michelucci, 2018 (ISBN-13 (pbk): 978-1-4842-3789-2)