Curriculum

Department of Electrical and Electronic Engineering

Undergraduates
Session: 2020-2021

Graduates
Session: 2020-2021

Shahjalal University of Science and Technology
Sylhet, Bangladesh

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Cover Design:
Dept of Architecture, SUST

Shahjalal University of Science and Technology
Sylhet-3114, Bangladesh
PABX: +88-0821-713491, 714479, 713850, 716123, 715393
Fax: +88-0821-715257, 725050
Website: www.sust.edu
E-mail: registrar@sust.edu

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OVERVIEW OF THE UNIVERSITY AND DEPARTMENT

(At a glance)

Name of the University
Shahjalal University of Science and Technology, Sylhet

Establishment of the University
25 August 1986

Founder Vice Chancellor of the University
Professor Dr. Sadruddin Ahmed Chawdhury

Current Vice Chancellor of the University
Professor Farid Uddin Ahmed

First Academic Session of the University
1990-1991

Website of the University
www.sust.edu

E-mail of the University
registrar@sust.edu

Name of the Department
Electrical and Electronic Engineering (EEE)

First Academic Session of the Department
(2010-2011)

Website of the Department
www.sust.edu/d/eee

E-mail of the Department
eee@sust.edu

PABX Extension of the Department
2408

Founder Head of the Department
Professor Dr. Muhammad Zafar Iqbal

Current Head of the Department
Dr Ifte Khairul Amin

Programs Offering
BSc (Engg.)

FACULTY LIST (Current)

SL. No.	Full Name	PABX	Cell Phone
	Assisociate Professors		
01.	Dr Ifte Khairul Amin		01911034624
02.	Mr. Biswajit Paul		01712554955
	Assistant Professors		
03.	Mr Md Rasedujjaman		
04.	Mr Arif Ahammad		01720122789
05.	Mr. Jibesh Kanti Saha		01680003287
05.	Mr. Tahmid Aziz Chowdhury		01720640456
06.	Mr. Hriteshwar Talukder		01745311342
07.	Md Asaduz Zaman Mamun		01515623326
08.	Ms. Nuren Zabin Shuchi		01521460665
09.	Mr. Showmik Singha		01712331122
	Lecturers		
10.	Nafis Imtiaz Rahman		01711519433
11.	Md. Ishfak Tahmid		01715279154

Ordinance for Semester System for Bachelor's Degree

(This ordinance will replace other ordinances/resolutions etc. on the issues described here; however, it will not affect ordinances/resolutions on issues not mentioned here.)

1. Student Admission

1.1 Undergraduate Admission:
The admission committee of the university will conduct the admission process for Bachelor's degree as per the rules. The student will be admitted in the first semester of an academic year in the individual discipline of different schools. However the admission of foreign students will be subjected to the verification of academic records as per the university rule.

1.2 Student Status and Student Level:
Every student has to maintain his/her student status by getting admission paying necessary fees and register for required credits every semester. Unless a student graduate early by taking courses in advance, every student has to get admission in every semester successively. For book keeping purpose a student's level will be expressed by his/her year and semester. A student will be transferred to next level if he/she completes or appears in 80% of his designated courses at his/her present level. Once a student reaches 4th year 2nd (5th year 2nd for Architecture) semester he/she will be kept at this level until he/she graduates.

1.3 Re-Admission:
A student has to take re-admission if his/her student status is not maintained or one or more semesters were cancelled because of disciplinary action against him/her. In case of semester cancellation the student has to get re-admission in the same semester. The level (Year and Semester) of re-admission will be determined by his completed/appeared credits. A student will be eligible for re-admission in the first year first semester of the subsequent session if he/she was present in at least 25% of the classes of his/her major courses or appeared at the semester final examination and his/her admission/semester fees was clear in the past semester/session. Re-admitted students will always be assigned the original Registration Number.

1.4 Student's Advisor:
After admission every batch of student will be assigned to a student's Advisor from the teacher of his/her discipline to guide him/her through the semester system. Advisors will always be accessible to the students and will be ready to mentor them in their academic activities, career planning and if necessary, personal issues. There will be a prescribed guideline for the Advisors to follow.

2. Academic Calendar

2.1 Number of Semesters:
There will be two semesters in an academic year. The first semester will start on 1st January and end on 30th June, the Second semester will start on 1st July and end on 31st December. The routine of the final examination dates along with other academic deadlines will be announced in the academic calendar at the beginning of each semester.

2.2 Duration of Semesters:
The duration of each semester will be as follows:

Classes and Preparatory weeks	15 weeks
Final Examination	04 weeks
Total	19 weeks

These 19 weeks may not be contiguous to accommodate various holidays and the Recess before the final examination may coincide with holidays. The final grading will be completed before the beginning of the next semester.

3. Course Pattern

The entire Bachelor's degree program is covered through a set of theoretical, practical, project, viva and seminar courses. At the beginning of every academic session a short description of every available course will be published by the syllabus committee of each discipline.

3.1 Course Development:

3.1.1 Major and Non-Major Courses:
Syllabus committee of every discipline will develop all the courses that will be offered by that particular discipline and has to be approved by the respective school and the Academic Council. These include major courses for the respective discipline as well as non-major courses that will be offered to other disciplines. Non-major courses will be developed with close cooperation of the disciplines concerned keeping into consideration of the need of that discipline.

3.1.2 Syllabus:
(a) Major and Non-Major Courses: Syllabus committee will select and approve the courses from major courses of the discipline as well as non-major courses offered by other disciplines to complete the syllabus. The syllabus committee will also select a group of courses as core-courses and without these courses a student will not be allowed to graduate even if he completes the credit requirement. The committee may assign pre-requisite for any course if deemed necessary.
(b) Second Major Courses: The syllabus committee will select a set of courses of 28-36 credits from the major courses for a second major degree.

3.1.3 Course Instruction:
At the beginning of every semester the course instructor has to make a detailed plan of the course instruction in the prescribed form and supply it to the head of the discipline to make it available to the students. The course plan should have the information about the suggested text books, number of lectures per topic, number and type of assignments, number and approximate dates of mid-semester

examinations and mandatory office hours reserved for the students of the course offered. If not otherwise mentioned the medium of instruction is always English.

3.2 Course Identification System:
Each course is designated by a three-letter symbol for discipline abbreviation followed by a three-digit number to characterize the course. To avoid confusion new or modified courses should never be identified by reusing a discontinued course number

3.2.1 Discipline Identification:
The three-letter symbol will identify a discipline offering the course as follows. If same course is offered to more than one discipline, if necessary, an extra letter shown in the list may be used after the three digits to specify the department receiving the non-major course.

		School of Applied Sciences and Technology:	
1.	ARC	Architecture	A
2.	CEP	Chemical Engineering and Polymer Science	B
3.	CEE	Civil and Environmental Engineering	C
4.	CSE	Computer Science and Engineering	D
5.	EEE	Electrical and Electronic Engineering	E
6.	FET	Food Engineering and Tea Technology	F
7.	IPE	Industrial and Production Engineering	G
8.	MEE	Mechanical Engineering	Q
9.	PME	Petroleum and Mining Engineering	H
		School of Life Sciences:	
10.	BMB	Biochemistry and Molecular Biology	I
11.	GEB	Genetic Engineering and Biotechnology	J
		School of Physical Sciences:	
12.	CHE	Chemistry	K
13.	GEE	Geography and Environment	L
14.	MAT	Mathematics	M
15.	OCG	Oceanography	S
16.	PHY	Physics	N
17.	STA	Statistics	O
		School of Social Sciences:	
18.	ANP	Anthropology	a
19.	BNG	Bangla	b
20.	ECO	Economics	c
21.	ENG	English	d
22.	PSS	Political Studies	e
23.	PAD	Public Administration	f
24.	SCW	Social Work	g
25.	SOC	Sociology	h
		School of Agriculture and Mineral Sciences:	
26.	FES	Forestry and Environmental Science	P
		School of Management and Business Administration:	
27.	BUS	Business Administration	i
		Institute of Information and Communication Technology	
28.	SWE	Software Engineering	W

3.2.2 Course Number:
The three-digit number will be used as follows:
(a) First Digit: The first digit of the three digit number will correspond to the year intended for the course recipient.
(b) Second Digit: A discipline should use the number 0 and 1 for the second digit to identify non-major courses. The digits 2-9 are reserved for major courses to identify the different areas within a discipline.
(c) Third Digit: The third digit will be used to identify a course within a particular discipline. This digit can be used sequentially to indicate follow up courses. If possible even numbers will be used to identify laboratory courses.

3.2.3 Course Title and Credit:
Every course will have a short representative course title, declaration if it is core course, a number indicating the total credits as well as reference to prerequisite courses if any.

3.2.4 Theory and Lab Course:
If a single course has both Theory and Laboratory/Sessional part, then the course must be split into separate Theory and Lab courses and both should have separate course number. A student may not register for a lab course without registering or completing the corresponding theory course.

3.3 Assignment of Credits:

3.3.1 Theoretical:
One lecture per week (or 13 lectures in total) of 1 hour duration per semester will be considered as one credit. (There will be 10 minutes recess between theory classes). A theory course will have only integer number of credits.

3.3.2 Laboratory Classes:
Minimum two contact hours of a laboratory class per week (or 26 contact hours in total) per semester will be considered as one credit. A laboratory course may have half integer credits with a minimum of 1 credit.

3.3.3 Seminar, Thesis, Projects, Monographs, Fieldwork, Viva etc.:
Will be assigned by the respective discipline.

3.4 Classification of the Courses:
The Bachelor's degree courses will be classified into several groups and the syllabus committee will finalize the curricula selecting courses from the groups shown below.

3.4.1 Major Courses:
A student has to take at least 70% courses from his/her own discipline. Out of these courses a section will be identified as core courses and every student of a particular discipline will be required to take those courses.

3.4.2 Non-Major Courses:
Every student is required to take at least 20% (including mandatory) courses from related disciplines. If any Non-Major course is declared as Core course a student is required to take that course to graduate. The Non-Major courses will be designed, offered and graded by the offering disciplines.

3.4.3 Other Courses:
After completion of the required mandatory, major and non-major courses a student may take few other courses of his/her choice not directly related to his/her discipline to fulfill the total credit requirement.

3.4.4 Credit-Only Courses:
The credit of these Credit-Only courses will be added to the total credits if passed but will not affect the CGPA as there will be no grades for these courses.

4. Course Registration

4.1 Registration:
A student has to register for his/her courses and pay necessary dues within the first two weeks of every semester. Departmental student advisor will advise every student about his/her courses and monitor his/her performances. A student at any level is expected to register the courses at his level provided he/she does not have any incomplete courses from previous levels. A student will not be allowed to appear in the examination if his/her semester and examination fee is not cleared.

4.2 Minimum and Maximum Credits:
A student, if s/he is not a clearing graduate, has to register for at least 12 credits minimum and 30 credits maximum every semester.

4.3 Incomplete Courses:
(i) If a student has incomplete courses, he/she has to register his/her available incomplete courses from preceding levels before s/he can register courses from current or successive levels. If an incomplete course is not offered in a given semester the student has to take the courses when it is offered next time. A student with incomplete courses will not be eligible for Distinction.

(ii) A student to register his/her incomplete courses, if offered, from proceeding semesters before s/he can register courses from current or successive semester, otherwise s/he takes the courses when the desired course is offered next time. A student will not be allowed to take 100 and 300 level and 200 and 400 level courses simultaneously. 100 level courses mean courses of 1st and 2nd semesters, 200 level courses mean courses of 3rd and 4th semesters and so on.

4.4 Course Withdrawal:
A student can withdraw a course by a written application to the Controller of Examinations through the Head of the discipline on or before the last day of instruction. The Controller of Examinations will send the revised registration list to the disciplines before the examination. There will be no record of the course in transcript if the course is withdrawn.

4.5 Course Repetition:
If a student has to repeat a failed or incomplete course and that course is not offered any more, the discipline may allow him/her to take an equivalent course from the current syllabus. For clearing graduates if any incomplete course is not offered in the running semester, the discipline may suggest a suitable course to complete the credit requirement.

5. Graduation Criteria

5.1 Major Degree:

5.1.1 Total Credits:
School of Physical Sciences, School of Social Sciences and School of Management and Business Administration have a requirement of 140 credits to graduate from its disciplines. School of Applied Sciences and Technology, School of Life Sciences and School of Agriculture and Mineral Science have requirement of 160 (200 for Architecture) credits for graduation.

5.1.2 Total Years:
A regular student is expected to graduate in 8 semesters (4 years) or in 10 semesters (5 years) for the discipline of Architecture. A student may graduate in shorter time period if s/he is willing to take extra courses in a systematic way. A student will be given 4 (2 years) extra semesters in addition to 8/10 semesters to complete his/her degree. The regular examination year will be identified by the session and the end-month (June or December) of the semester the student graduates.

5.1.3 Early Graduation:
A student may graduate early by completing courses in advance, in that case he does not need to pay tuition or get admission in subsequent semesters. However a student will not be able to start master's degree one session earlier unless he graduates two semesters early.

5.1.4 Minimum Credit for a Clearing Graduate:
For a clearing graduate (8th and subsequent semesters) condition for maximum and minimum credit requirements is relaxed.

5.1.5 Break in study:
Those students who have not been able to achieve their degrees by participating in the ascertained 12th (for ARC department 14th) semester final exams will have the opportunity to do so by enrolling into 2 (two) running semesters back to back if after

the publications of their results of the 12th (for ARC department 14th) semester final exam, it becomes evident that they have completed at least 80% of their total credits. In case of such students, on the tabulation sheet, result sheet, certificate, transcript, grade sheet, etc., number of total semesters shall be stated instead of the word "Irregular." As for irregular students, studentship shall be annulled after the aforesaid 2 (two) semesters have come to an end.

5.2 Second Major Degree:

5.2.1 Total Credits:
A student may apply for a second major degree if he/she completes an extra 28-36 credit requirement designated by the offering discipline.

5.2.2 Total Semesters:
A student has to complete the credit requirement of second major degree within 8 regular and 4 extra semesters.

5.2.3 Requirement of Major Degree:
A student will not be given a second major degree if he/she fails to complete his regular major degree. A student will not be allowed to enroll in Masters program before completion of his/her second major degree even if he/she complete his/her major degree requirement.

5.2.4 Registration Criteria:
An offering discipline will decide on the number of seats for second major, enrollment criteria and get it approved from the academic council. Students willing to get a second major have to apply to the offering discipline for enrollment and the discipline will enroll them as per the admission criteria. During registration enrolled students have to get their courses approved from the offering department completing a separate registration form.

5.2.5 Class Routine:
After enrollment a regular student may start taking the second major courses starting 3rd semester. The class routine may be arranged to accommodate the student need.

5.2.6 Certificate and Mark sheet:
A student completing the requirement will be given an additional certificate and grade sheet for his second major degree.

6. Examination System

A student will be evaluated continuously in the courses system, for theoretical classes s/he will be assessed by class participation, assignments, quizzes, mid-semester examinations and final examination. For laboratory work s/he will be assessed by observation of the student at work, viva-voce during laboratory works, from his/her written reports and grades of examinations designed by the respective course teacher and the examination committee.

6.1 Distribution of Marks:
The marks of a given course will be as follows:

Class Attendance	10%
Class performance	10%
Assignments and Mid-Semester Examinations	20%
Final Examination	60%

6.1.1 Class Participation:
The marks for class participation will be as follows:

Attendance (Percentage)	Marks	Attendance (Percentage)	Marks	Attendance (Percentage)	Marks
95 and above	10	80 to 84	7	65 to 69	4
90 to 94	9	75 to 79	6	60 to 64	3
85 to 89	8	70 to 74	5	Less than 60	0

A student will not be allowed to appear at the examination of a course if his/her class attendance in that course is less than 50%.

6.1.2 Assignments and Mid-Semester Examinations:
There should be at least two mid-semester examinations for every course. The course teacher may decide the relative marks distribution between the assignments, tutorial and mid-semester examinations, however at least 50% contribution should come from the mid-semester examinations. The answer script should be returned to the students as it is valuable to their learning process.

6.1.3 Final Examination:
The final examination will be conducted as per the Semester Examination Ordinance.
(a) Duration of the Final Examination: There will be a 3-hour final examination for every course of 3 credits or more after the 13th week from the beginning of the semester. Courses less than 3 credits will have final examination of duration 2 hours.
(b) Evaluation of Answer Script: The students of the School of Applied Science and Technology and the School of Agriculture and Mineral Sciences will have two answer scripts to answer separate questions during final examination. Two separate examiner will grade the two scripts separately and the marks will be added together to get the final mark. For the students of the other schools there will be a single answer script which will be evaluated by two examiners. The two marks will be averaged and if the marks by the two examiners differ by 20% or more the concerned answer scripts will be examined by a third examiner and the two closest marks among the three will be averaged to get the final mark.

7. Grading System

7.1 Letter Grade and Grade Point:

Letter Grade and corresponding Grade-Point for a course will be awarded from the roundup marks of individual courses as follows:

Numerical Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00

7.2 Calculation of Grades

7.2.1 GPA:
Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses completed by a student in a semester.

7.2.2 CGPA:
Cumulative Grade Point Average (CGPA) of only major and both major and second major degree will be calculated by the weighted average of every course of previous semesters along with the present semester. For clearing graduates if the roundup value of the third digit after decimal is nonzero the second digit will be incremented by one. A student will also receive a separate CGPA for his second major courses.

7.2.3 F Grades:
A student is given an 'F' grade if he fails or is absent in the final examination of a course. If a student obtains an 'F' grade his grade will not be counted for GPA and s/he has to repeat the course. An 'F' grade will be in his/her record and s/he will not be eligible for Distinction.

8. Distinction

8.1 Distinction:
Candidates for four-year Bachelor degree will be awarded the degree with Distinction if his/her overall CGPA is 3.75 or above. However, a student will not be considered for Distinction if (a) s/he is not a regular student (has semester drop, incomplete courses in any semester or break of study) (b) has 'F' grade in one or more courses.

Ref.: This Ordinance was approved in the 126th Academic Council (26 June 2013). Clause 3.4.1 was cancelled in 127th Academic Council (27 August 2013). 128th Academic Council (21 November 2013) decided to make it effective from 01 January 2014.

শাহজালাল বিজ্ঞান ও প্রযুক্তি বিশ্ববিদ্যালয়ের বিএনসিসি ক্যাডেটদের জন্য ঐচ্ছিক বিষয় হিসেবে নির্ধারিত

MSC004 (3.0 Credits)
MILITARY SCIENCE (সামরিক বিজ্ঞান)

পঠিত বিষয় (তত্ত্বীয় ও ব্যবহারিক): বি এন সি সি'র ইতিহাস-ঐতিহ্য, বি এন সি সি'র সাংগঠনিক কাঠামো, মহান স্বাধীনতা যুদ্ধের পঠভূমি ও কারণ, স্বাধীনতা যুদ্ধের সেক্টর সমূহ, ড্রিল, কুচকাওয়াজ, ম্যাপ রিডিং, যুদ্ধের নানা কৌশল, যুদ্ধে ব্যবহৃত অস্ত্রের পরিচয়, বাংলাদেশের সশস্ত্র বাহিনীর পরিচয়, নেতৃত্বের বৈশিষ্ট্য, শরীর চর্চা, প্রাথমিক চিকিৎসা, সমাজ সেবা, দুর্যোগ ব্যবস্থাপনা, ভুমিকম্প ব্যবস্থাপনা, ঘূর্ণিঝড় ব্যবস্থাপনা, অগ্নি নির্বাপনের কৌশল, সাংস্কৃতিক প্রশিক্ষণ ইত্যাদি।

সহায়ক গ্রন্থ :
বি এন সি সি: সামরিক বিজ্ঞান সদর দপ্তর কর্তৃক নির্ধারিত ও প্রকাশিত।

Department of Electrical and Electronic Engineering
Shahjalal University of Science & Technology
Sylhet-3114, Bangladesh

Curriculum/Syllabus for B. Sc. (Engg.) Program
Session: 2020-21

Vision Statement

The Department of Electrical and Electronic Engineering, SUST aspires to become a leader in producing globally competent electrical engineers, researchers, and entrepreneurs and thereby contribute value to the knowledge-based economy and society at large.

Mission

M1. To provide state-of-the-art course contents which will help students demonstrating their creativity.
M2. To create a bridge between industry and academia by framing curriculum based on industrial and societal needs.
M3. To foster students in quality research by utilizing existing resources which will facilitate their expertise in both industry and academia.
M4. To enable students to develop skills to solve complex technological problems of current times and provide a framework for promoting collaborative and multidisciplinary activities.
M5. To inculcate moral and ethical values among the faculty and students.
M6. To prepare the graduates to serve the society and nation by applying their knowledge and expertise to tackle the challenges of the sustainable development while respecting economic and environmental constraints.

Program Name: B.Sc. (Engg.) in Electrical and Electronic Engineering
Program Educational Objectives (PEO)

The EEE department has defined a set of objectives that translates its mission into measurable and defined tasks. The objectives of the curriculum are categorized in the following dimensions:

a. Intellectual curiosity
b. Career preparation
c. Professionalism and leadership
d. Ethics and moral values

In order to attain these goals, the following are the program educational objectives (PEO)-

PEO1. To equip graduates with a solid foundation in engineering, mathematics, sciences, and soft skills for diverse careers such as communications, electric power, electronics and digital systems.
PEO2. To help students to develop a basic set of skills to perform proficiently in laboratories**.**
PEO3. To make the students able to demonstrate high level analytical and critical thinking skills to solve real-life conceptual and quantitative problems in a wide variety of sectors, such as power systems, communication technology and development of energy efficient electronic devices.
PEO4. To motivate graduates to continuously learn new concepts, identify new directions, and adapt in response to the needs of a rapidly changing world.
PEO5. To enhance the skill for communicating scientific results effectively in written, oral and in interactive presentation.
PEO6. To inspire the graduates to exhibit professionalism, punctuality and ethics in both personal and professional endeavors.
PEO7. To make graduates ready for professional environment in which they become leaders, work in multidisciplinary teams, make decisions that are socially, ethically and economically responsible.

PEO to Mission Statement Mapping

Mission /PEO	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6	PEO7
M1	X			X	X		
M2		X	X			X	
M3	X	X		X	X	X	X
M4			X	X	X	X	
M5		X				X	
M6			X				X

Program Learning Outcome (PLO)

After graduation from our program in EEE, the graduates will be able to:

PLO1. explain and apply the theoretical concepts of engineering, mathematics, and science to solve the real-world problems related to electrical and electronic engineering with appropriate considerations for global and societal needs;
PLO2. apply acquired knowledge and expertise to meet the challenges of sustainable development while keeping in mind the economical, societal and environmental constraints;
PLO3. operate and calibrate equipment in laboratories;
PLO4. design and conduct experiments, analyze the acquired results, interpret data and synthesize valid conclusions;
PLO5. demonstrate capability to identify, formulate and research through relevant literature review along with the ability to organize the findings and data for proper documentation;
PLO6. demonstrate the ability to communicate effectively across a variety of audiences;
PLO7. exhibit capability to function collaboratively as a member of a team to achieve specified and measurable results;
PLO8. develop flexibility, adaptability, and time management skills commensurate with industry productivity needs;
PLO9. recognize the need for and demonstrate the ability to engage in life-long learning towards professional growth;
PLO10. understand professional, ethical and moral responsibility and exhibit ability to abide by the terms of agreement that define their employment;

PLO11. apply acquired knowledge and expertise to serve the society and nation at large.

Program Objectives (PEO/PO) to Program Learning Outcome (PLO) Mapping

PLO/ PEO	PEO1	PEO2	PEO3	PEO4	PEO5	PEO6	PEO7
PLO1	X			X	X	X	X
PLO 2	X				X		
PLO 3	X		X				
PLO 4		X			X	X	
PLO 5	X	X	X	X	X	X	X
PLO 6		X				X	
PLO 7						X	
PLO 8	X			X	X		
PLO 9			X		X		
PLO 10						X	
PLO 11		X		X			X

Graduate Profile:

Graduates of the department of EEE are expected to have the following attributes:

a. Deep knowledge in Electrical and Electronic Engineering
b. Numeracy and analytical skills
c. Complex problem-solving and design skills
d. Entrepreneurship and innovation skills
e. Communication skills
f. Interpersonal and teamwork skill
g. Professionalism and commitment to society
h. Impact of engineering on society and the environment
i. Intercultural and ethical competency
j. Life-long learning

Semester wise Curriculum Breakdown:

One-semester credit hour represents one class hour or two laboratory hours per week. An academic semester represents 13 weeks of classes exclusive of final exams. Semester wise breakdown of the curriculum structure for 2020-21 session are shown.

First Year: 1st Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 121	Electrical Circuits I	3	0	3.0
EEE 122	Electrical Circuits I Lab	0	3	1.5
CSE 103E	Introduction to Computer Language	2	0	2.0
CSE 104E	Introduction to Computer Language Lab	0	4	2.0
ENG 101E	Effective Communication in English	2	0	2.0
ENG 102E	English Language Lab I	0	2	1.0
MAT 101E	Differential and Integral Calculus	3	0	3.0
PHY 103E	Physics I	3	0	3.0
PHY 104E	Physics I Lab	0	3	1.5
SSS 100	History of the Emergence of Independent Bangladesh	3	0	3.0
Total		16	12	22.0

First Year: 2nd Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 123	Electrical Circuits II	3	0	3.0
EEE 124	Electrical Circuits II Lab	0	3	1.5
PHY 207E	Physics II	3	0	3.0
PHY 204E	Physics II Lab	0	3	1.5
CHE 101E	Chemistry	3	0	3.0
CHE 102E	Chemistry Lab	0	3	1.5
ARC 108E	Computer Aided Engineering Drawing	0	3	1.5
MAT 103E	Co-ordinate Geometry and Linear Algebra	3	0	3.0
ECO 105E	Principles of Economics	3	0	3.0
Total		15	12	21.0

Second Year: 1st Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 221	Electronics I	3	0	3.0
EEE 222	Electronics I Lab	0	3	1.5

EEE 231	Signals and Linear Systems	3	0	3.0
EEE 223	Electrical Machines I	3	0	3.0
EEE 224	Electrical Machines I Lab	0	3	1.5
EEE 210	Numerical Analysis Lab	0	2	1.0
BUS 243E	Cost and Management Accounting	3	0	3.0
MAT 201E	Vector Analysis and Complex Variables	3	0	3.0
Total		15	8	19.0

Second Year: 2nd Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 225	Electrical Machines II	3	0	3.0
EEE 226	Electrical Machines II Lab	0	3	1.5
EEE 227	Electronics II	3	0	3.0
EEE 228	Electronics Lab II	0	3	1.5
EEE 229	Electromagnetic Fields and Waves	3	0	3.0
EEE 232	Electrical Services Design	0	3	1.5
STA 202E	Basic Statistics & Probability	3	0	3.0
MAT 203E	Ordinary and Partial Differential Equations	3	0	3.0
Total		15	9	19.5

Third Year: 1st Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 323	Digital Electronics	3	0	3.0
EEE 324	Digital Electronics Lab	0	3	1.5
EEE 325	Power System I	3	0	3.0
EEE 326	Power System I Lab	0	3	1.5
EEE 327	Electrical Properties of Materials	3	0	3.0
EEE 331	Digital Signal Processing I	3	0	3.0
EEE 332	Digital Signal Processing I Lab	0	3	1.5
MEE 313E	Fundamentals of Mechanical Engineering	3	0	3.0
Total		15	9	19.5

Third Year: 2nd Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 329	Basic Communication Engineering	3	0	3.0
EEE 330	Basic Communication Engineering Lab	0	3	1.5

EEE 333	Microprocessor & Interfacing	3	0	3.0
EEE 334	Microprocessor & Interfacing Lab	0	3	1.5
EEE 335	Control System I	3	0	3.0
EEE 336	Control System I lab	0	3	1.5
EEE 337	Power System II	3	0	3.0
EEE 339	Power Electronics	3	0	3.0
EEE 340	Power Electronics Lab	0	3	1.5
Total		15	12	21.0

Fourth Year: 1st Semester

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 400	Project/Thesis (Initial work)	0	4	2.0
EEE 421	Solid State Devices	3	0	3.0
EEE 455	VLSI Design and Testing	3	0	3.0
EEE 456	VLSI Design and Testing Lab	0	3	1.5
EEE/ CSE 4**	Option I	3	0	3.0
EEE/ CSE 4**	Option II	3	0	3.0
EEE/ CSE 4**	Option II Lab	0	3	1.5
EEE/ CSE 4**	Option III	3	0	3.0
EEE 402	Industrial Training	As required	As required	1.0
Total		15	10	21.0

Fourth Year: 2nd Semester*

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 408	Project/Thesis	0	8	4.0
EEE 445	Power System Protection	3	0	3.0
EEE 446	Power System Protection Lab	0	3	1.5
EEE/ CSE 4**	Option IV	3	0	3.0
EEE/ CSE 4**	Option V	3	0	3.0
EEE 4**	Option VI	3	0	3.0
EEE 4**	Option VI Lab	0	3	1.5
EEE 410	Viva voce			1.0
Total		12	14	20.0

* Students must complete minimum 15.0 credits in this semester

Total Credits: 22.0+21.0+19.0+19.5+19.5+21.0+21.0+20.0=163.0

List of Options

Option I Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 443	Power Plant Engineering	3	0	3.0
EEE 451	Analog Integrated Circuits Design	3	0	3.0
EEE 453	Processing and Fabrication Technology	3	0	3.0
EEE 473	Digital Signal Processing II	3	0	3.0
EEE 495	Fundamentals of Nano electronics and Quantum Transport	3	0	3.0

Option II Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 489	Renewable Energy Systems	3	0	3.0
EEE 490	Renewable Energy Systems Lab	0	3	1.5
EEE 423	Computer Interfacing & Industrial Automation	3	0	3.0
EEE 424	Computer Interfacing & Industrial Automation lab	0	3	1.5
EEE 457	Microcontroller System Design	3	0	3.0
EEE 458	Microcontroller System Design Lab	0	3	1.5
EEE 475	RF and Microwave Engineering	3	0	3.0
EEE 476	RF and Microwave Engineering Lab	0	3	1.5

Option III Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 439	Electrical Machines III/ Energy Conversion III	3	0	3.0
EEE 459	Compound Semiconductor and Hetero-Junction Devices	3	0	3.0
CSE 497	Numerical Analysis	3	0	3.0

Option IV Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 449	Power System Reliability	3	0	3.0
EEE 465	Optoelectronics	3	0	3.0
EEE 483	Telecommunication Engineering	3	0	3.0
CSE 329	Computer Architecture	3	0	3.0

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 497	Introduction to Non-linear Optics and Nano-photonics	3	0	3.0

Option V Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 471	Power System Operation and Control	3	0	3.0
EEE 467	Semiconductor Device Theory	3	0	3.0
EEE 469	Energy Audit and Management	3	0	3.0
EEE 485	Cellular Mobile and Satellite Communication	3	0	3.0
EEE 499	Quantum Computing	3	0	3.0

Option VI Courses

Course Code	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 487	Control System II	3	0	3.0
EEE 488	Control System II Lab	0	3	1.5
EEE 481	Optical Fiber Communication	3	0	3.0
EEE 482	Optical Fiber Communication Lab	0	3	1.5
EEE 491	Biomedical Instrumentation	3	0	3.0
EEE 492	Biomedical Instrumentation Lab	0	3	1.5
EEE 493	Measurement and Instrumentation	3	0	3.0
EEE 494	Measurement and Instrumentation Lab	0	3	1.5
CSE 361	Computer Networking	3	0	3.0
CSE 362	Computer Networking Lab	0	3	1.5
EEE 461	VLSI for Industrial Applications	3	0	3.0
EEE 462	VLSI for Industrial Applications Lab	0	3	3.0
EEE 463	Programmable ASIC Design	3	0	3.0
EEE 464	Programmable ASIC Design Lab	0	3	1.5
EEE 447	High Voltage Engineering	3	0	3.0
EEE 448	High Voltage Engineering Lab	0	3	1.5

Teaching and Assessment Strategy

A student will be evaluated continuously in the courses system, for theoretical classes s/he will be assessed by class participation, assignments, quizzes, mid-semester examinations and final examination. For laboratory work s/he will be assessed by observation of the student at work, viva-voce during laboratory works,

from his/her written reports and grades of examinations designed by the respective course teacher and the examination committee.

1. Distribution of Marks:
The marks of a given course will be as follows:

Class Attendance	10%
Assignments and Mid-Semester Examinations	20%
Class Performance	10%
Final Examination	60%

2. Class Attendance:
The marks for class participation will be as follows:

Attendance (Percentage)	Marks	Attendance (Percentage)	Marks	Attendance (Percentage)	Marks
95 and above	10	80 to 84	7	65 to 69	4
90 to 94	9	75 to 79	6	60 to 64	3
85 to 89	8	70 to 74	5	Less than 60	0

A student will not be allowed to appear at the examination of a course if his/her class attendance in that course is less than 50%.

3. Assignments and Mid-Semester Examinations:
There should be at least two mid-semester examinations for every course. The course teacher may decide the relative marks distribution between the assignments, tutorial and mid-semester examinations, however at least 50% contribution should come from the mid-semester examinations. The answer script should be returned to the students as it is valuable to their learning process.

4. Final Examination:
The final examination will be conducted as per the Semester Examination Ordinance.
(a) **Duration of the Final Examination:** There will be a 3-hour final examination for every course of 3 credits or more after the 13th week from the beginning of the semester. Courses less than 3 credits will have final examination of duration 2 hours.
(b) **Evaluation of Answer Script:** The students of the School of Applied Sciences and Technology will have two answer scripts to answer separate questions during final examination. Two separate examiners will grade the two scripts separately and the marks will be added together to get the final mark.

5. Project/Thesis:
The marks of Project/Thesis will be as follows:

Dissertation	30%	Evaluated by two Teachers (15+15)
Project/Thesis Work	30%	Evaluated by Supervisor.
Presentation	40%	Evaluated by a panel of teachers.

Grading System

1. Letter Grade and Grade Point:
Letter Grade and corresponding Grade-Point for a course will be awarded from the roundup marks of individual courses as follows:

Numerical Grade	Letter Grade	Grade Point
80% and above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 75%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00

2. Calculation of Grades

GPA:
Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses completed by a student in a semester.

CGPA:
Cumulative Grade Point Average (CGPA) of only major and both major and second major degree will be calculated by the weighted average of every course of previous semesters along with the present semester. For clearing graduates if the roundup value of the third digit after decimal is nonzero the second digit will be incremented by one. A student will also receive a separate CGPA for his second major courses.

F Grades:
A student is given an 'F' grade if he fails or is absent in the final examination of a course. If a student obtains an 'F' grade his grade will not be counted for GPA and s/he has to repeat the course. An 'F' grade will be in his/her record and s/he will not be eligible for Distinction.

Distinction:
Candidates for four-year Bachelor degree will be awarded the degree with Distinction if his/her overall CGPA is 3.75 or above. However, a student will not be considered for Distinction if (a) s/he is not a regular student (has semester drop, incomplete courses in any semester or break of study) (b) has 'F' grade in one or more courses.

Shahjalal University of Science and Technology
School of Applied Sciences and Technology
Department of Electrical and Electronic Engineering

COURSE PROFILE
First Year

Course Title: Electrical Circuits I	Year/Semester:1/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 121	Credits: 3.0	Contact hours: 3 hours lecture per week

Rationale
This is an introductory course in Electrical and Electronic Engineering, introducing simple electrical DC circuits as well as the technical skills to facilitate necessary knowledge to analyze such simple and complex circuits. It is a course suitable for students pursuing further studies in electrical, electronic or telecommunications engineering as well as some other related engineering disciplines including computer engineering. In the practical section, it provides hands-on experience in building and testing circuits. It is packaged in such a way that students, having taken this course, can go away and build and analyze some practical, useful devices afterwards. It is a pre-requisite for the subsequent course on Circuits and Signals.

Course Objectives are
- To disseminate knowledgeabout electrical charge, voltage, current and power
- To give the idea of basic concepts of DC circuit behavior.
- To develop mathematical representations for simple RLC DC circuits.
- To teach the students methods to solve mathematical representations for simple RLC DC circuits of dependent and independent sources.
- To make the students understand the use of circuit analysis theorems and methods.
- To give idea about magnetic circuits

Course Contents:
Circuit variables and elements: Voltage, current, power, energy, independent and dependent sources, and resistance.
Basic laws: Ohm's law, Kirchhoff's current and voltage laws.
Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.
Techniques of circuit analysis: Nodal and mesh analysis including super node and super mesh.
Network theorems: Source transformation, Thevenin's, Norton's and superposition theorems with applications in circuits having independent and dependent sources, maximum power transfer condition and reciprocity theorem.
Energy storage elements: Inductors and capacitors, series parallel combination of inductors and capacitors.
Responses of RL and RC circuits: Natural and step responses.

Magnetic quantities and variables: Flux, permeability and reluctance, magnetic field strength, magnetic potential, flux density, magnetization curve.
Laws in magnetic circuits: Ohm's law and Ampere's circuital law.
Magnetic circ uits: series, parallel and series-parallel circuits.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Define charge, current, voltage and power, resistance etc.
CLO 2	Describe the basic circuit laws and circuit analysis techniques.
CLO 3	Explain DC circuit analysis.
CLO 4	Describe the basic idea about magnetic circuits and Electric Flux.
CLO 5	Understand the energy storage elements.
CLO 6	Apply different Network Theorems for circuit analysis

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X				X						
CLO 2	X	X									
CLO 3	X	X		X							
CLO 4		X									
CLO 5											
CLO 6	X				X						X

Recommended Books
1. Fundamentals of Electric Circuits by Charles K. Alexander, Mathew N.O. Sadiku R.
2. Electric Circuits by James W. Nilsson, Susan Riedel
3. Introductory Circuit Analysis by Robert L. Boylestad

Course Title: Electrical Circuit I Lab	Year/Semester:1/1	Course Status: Lab (Compulsory, Major)
Course Code:EEE 122	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 121 (Electrical Circuits I)		

Rationale
In this course students will perform experiments to verify practically the theories and concepts learned in EEE 121. Theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in electrical circuits' analysis. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits.

Course Objectives are
- To provide the students with capability of implementing different real-life dc circuits.

- To provide the students with the techniques of solving of different types of circuits by network theorem.
- To teach the voltage, current and load relationship in a network.
- To facilitate necessary knowledge about transient analysis and steady state analysis of a capacitor and inductor network.

Course Contents:
This lab has two parts, hardware experimentation and software simulation. In this course students will perform experiments to verify practically the theories and concepts learned in EEE-121.
1. To make students familiar with the operation of different electrical instruments.
2. To verify the following theorems for DC circuits:
i. KCL and KVL theorem,
ii. Superposition theorem,
iii. Thevenin's theorem,
iv. Norton's theorem and
v. Maximum power transfer theorem

3.To perform other experiments relevant to this course.
Students will verify the theories and concepts learned in EEE 121 using simulation software like PSpice and MATLAB. Students will also perform specific design of electrical and electronics circuits theoretically and by simulation.

1. To make students familiar with the operation of different electrical instruments.
2 . To verify the following theorems for DC circuits:
i. Superposition theorem,
ii. Thevenin's theorem,
iii. Norton's theorem,
iv. Maximum power transfer theorem and
v. KCL and KVL theorem.

3. To perform other experiments relevant to this course.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Recognize different types of electrical instruments and measuring devices.
CLO 2	Describe the idea about complex circuit network.
CLO 3	Interpret transient response about capacitor and inductor circuits.
CLO 4	Design experiments to interpret different types of circuit analysis theorem and laws
CLO 5	Implement electrical circuits for real life application.
CLO 6	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X	X							
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5	X										
CLO 6	X						X				X

Recommended Books
1. Fundamentals of Electric Circuits by Charles K. Alexander, Mathew N.O. Sadiku R.
2. Electric Circuits by James W. Nilsson, Susan Riedel
3. Introductory Circuit Analysis by Robert L. Boylestad

Course Title: Introduction to Computer Language	Year/Semester:1/1	Course Status: Theory (Compulsory, Non-major)
Course Code: CSE 103E	Credits: 2.0	Contact hours: 2 hours lecture per week
Pre-requisite: None		

Rationale
To familiarize the student with basic concepts of computer programming and developer tools. To present the syntax and semantics of the "C" language as well as data types offered by the language. To allow the students to write their own programs using standard language infrastructure regardless of the hardware or software platform.

Objectives
- To provide students a basic understanding of computer hardware and how a computer works.
- To teach students the basic terminology used in computer programming
- To teach how to write, compile and debug programs in C language
- To help students write programs involving decision structures, loops and functions
- To teach the students the concepts and usage of pointers
- To teach students good programming practices and how to build up their own logics and how to implement them.

Course Contents:
Computer Basics:Concept on Computer Hardware, Software and its classification. C-Language:Preliminaries, Program constructs variables and data types in C. Input and output. Character and formatted I/O; Arithmetic Expressions and Assignment statements; Loops and Nested loops; Decision making; Arrays, Functions; Arguments and local variables, Calling Functions and arrays. Recursion and Recursive functions; Structures within structure. Files; File functions for sequential and Random I/O. Pointers; Pointers and structures; Pointer and functions; Pointer and arrays; Operation and Pointer; Pointer and memory addresses; Operations on Bits; Bit Operation; Bit field; Advanced features; Standard and library.

Course Learning Outcomes: After the successful completion of the course, the student will be able to-

CLO 1	Understand the concepts of computer hardware and how it works.
CLO 2	Recall the basic terminology used in computer programming
CLO 3	Construct, compile and debug programs in C language
CLO 4	Apply control-flow tools such as loop, if-else etc.
CLO 5	Understand the usage of pointers, structures and some advanced topics.
CLO 6	Employ good programming practices.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X		X								
CLO 2	X		X								
CLO 3	X		X								
CLO 4	X		X								
CLO 5	X		X		X						
CLO 6								X		X	X

Recommended Books

01. Schaum's Outline of Programming with C by Byron S. Gottfried
02. C: The Complete Reference by Herbert Schildt

Course Title: Introduction to Computer Language Lab	Year/Semester:1/1	Course Status: Lab (Compulsory, Non-major)
Course Code: CSE 104E	Credits: 2.0	Contact hours: 4 hours lab per week
Pre-requisite: None		

Rationale:

To familiarize the student with basic concepts of computer programming and developer tools. To present the syntax and semantics of the "C" language as well as data types offered by the language. To allow students to write their own programs using standard language infrastructure regardless of the hardware or software platform.

Objectives:

- To develop skills to work with C++ compilers and how to use run programs on the computer.
- Foster the analytical and critical knowledge to build up logic and implement them using C.
- To facilitate necessary knowledge about how todesign programs involving decision structures, loops and functions
- To develop skills to debug codes by giving an in depth idea about different syntax errors, exceptions and how to fix them.

- To facilitate necessary knowledge about the concepts and usage of pointers, structures and some advanced topics.
- To provide the knowledge of good programming practices.

Course Contents:

Laboratory works based on the theory course.

Course Learning Outcomes: After the successful completion of the course, the student will be able to-

CLO 1	Recognize C compilers and necessary tools to run programs on the computer.
CLO 2	Interpret logic and implement them using C.
CLO 3	Design programs involving decision structures, loops and functions
CLO 4	Debug codes by giving means of an in depth idea about different syntax errors, exceptions and how to fix them.
CLO 5	Implement good programming practices.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X		X							
CLO 2		X		X							
CLO 3		X		X							
CLO 4		X		X							
CLO 5								X		X	X

Recommended Books

1. Schaum's Outline of Programming with C by Byron S. Gottfried
2. C: The Complete Reference by Herbert Schildt

Course Title: Effective Communication in English	Year/Semester:1/1	Course Status: Theory (Compulsory, Non-major)
Course Code: ENG 101E	Credits: 2.0	Contact hours: 2 hours lecture per week
Pre-requisite: None		

Rationale

This course will develop two basic skills i.e. reading and writing. A variety of reading strategies and texts will be used to effectively develop first year students' academic reading skills thereby facilitating their future study. Also, the course focuses on developing the writing skills of students by familiarizing them with grammar rules, providing them with practice thereby enabling them to demonstrate the accurate use of grammar in their writing.

Course Objectives are

(i) To enable students to write with accuracy

(ii) To facilitate effective and comprehensible writing
(iii) To raise awareness of common errors that occur in writing
(iv) To develop student's ability to understand write-ups on issues of general concern.
(v) To improve the vocabulary of learners for effective communication.

Course Contents:

a) Reading

- Different Reading Strategies
- Guessing Meaning from the Context
- Critical Reading (Analyze)
- Critical Reading (Synthesize)
- Critical Reading (Evaluate)
- Annotation
- Summary Writing
- Material
- A selection of 08-10 editorials and reports from newspapers/magazines/journals,etc
- Reading texts in New Headway Upper Intermediate Student's Book (Current edition)
- Selected passages from recommended books
- A selection of other material may be supplied as handouts as deemed necessary by the instructor.

b) Writing

- Forms and functions of different word categories (Noun, verb, adjective, etc.)
- Aspects and uses of tense
- Subject-verb agreement
- Use of infinitive, gerund, present participle, past participle, modals, causatives,
- conditionals, subjunctives, modals.
- Use of sentence connectors/ cohesion markers/ punctuation
- Effective combination of sentences (simple, complex, compound)
- Developing a paragraph

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	apply grammar rules
CLO 2	produce grammatically correct meaningful sentences
CLO 3	express oneself correctly by using appropriate words, phrases, sentences or ideas
CLO 4	critically reflect on a text (grasp abstract ideas and interpret them effectively, arrive at well-reasoned conclusions and solutions).
CLO 5	extract information from passages accurately

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/	PLO	PLO	PLO	PLO	PL	PL	PLO	PLO	PLO	PLO	PLO

CLO	1	2	3	4	O 5	O 6	7	8	9	10	11
CLO 1		X		X							
CLO 2		X		X							
CLO 3		X		X							
CLO 4		X		X							
CLO 5								X		X	X

Recommended Books

1. Tibbits, E. E. ed. Exercises in Reading Comprehension. Longman
2. Liz and John Soars. (Current edition). New Headway Upper Intermediate Student's Book.
3. Oxford : Oxford University Press
4. Cliff's TOEFL
5. Other Resources recommended by course instructors

Course Title: English Language Lab I	Year/Semester:1/1	Course Status: Lab (Compulsory, Non-major)
Course Code: ENG 102E	Credits: 1.0	Contact hours: 2 hours lab per week
Pre-requisite:		

Rationale

This course is designed to improve the speaking and listening skills of students in the English language. Emphasis is laid on proper pronunciation for accurate articulation and recognition of speech sounds as well as correct stress, intonation and language use in varied situations.

Course Objectives are

(i) To enable students' understanding of the variations in pronunciation
(ii) To teach proper pronunciation and accurate articulation.
(iii) To facilitate appropriate stress and intonation in speech.
(iv) To encourage use of English effectively in everyday situations.
(v) To ensure overall improvement of oral communication through listening and speaking.

Course Contents:

(a) Speaking

- Articulators
- English Phonetic Alphabet (British and American) and International Phonetic Alphabet
- (IPA)
- Stress rules of English
- Intonation rules and functions of intonation
- Communication Styles and Cultural Context
- Fluency, mistakes, misunderstandings, audience, taboos, self-esteem, confidence
- Activities: dialogue, debate, extempore speech, interview, role-play

(b) Listening

- Basics of listening

- Various types of Pronunciation
- IPA, RP, Transcription
- Different accents and intonation patterns
- Activities for Meaning-focused Listening, Information Transfer Strategies,
- Listening Practice through selection of audio clips.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	read the symbols of the International Phonetic Alphabet used to represent the sounds of the English language.
CLO 2	understand all that is being said in English in varied accents
CLO 3	interpret information accurately
CLO 4	apply appropriate intonation and stress patterns in English words and sentences.
CLO 5	produce continuous speech clearly and convincingly.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X	X							
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5	X										

Recommended Books

1. Anderson, A. & Lynch, T. Listening. Oxford: Oxford University Press. 1988
2. Hancock, Mark. English Pronunciation in Use. New York: Cambridge University Press. 2004
3. Anderson, Kenneth, et al. Study Speaking. Cambridge University Press, 2007
4. Hancock, Mark. English Pronunciation in Use. Cambridge University Press, 2004
5. Jones, Daniel. Cambridge English Pronunciation Dictionary. Cambridge University Press, 2011
6. Richards J, et al. Person to Person. Oxford University Press, 2007
7. Richards, Jack C, and David Bohlke. Speak Now: 1. Oxford University Press, 2013
8. Roach, Peter. English Phonetics and Phonology. Cambridge University Press, 2009

Course Title: Differential and Integral Calculus	Year/Semester:1/1	Course Status: Theory (Compulsory, Non-major)
Course Code: MAT 101E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale: It is often said that Mathematics is the language of science and calculus, the branch of mathematics is much more than a language which eventually develops thinking and problem solving skills. Calculus deals with the calculation of instantaneous rates of change (differential calculus) and the summation of infinitely many small factors to determine some whole (integral calculus). It is considered to be one of the greatest achievements of the human intellect and focuses on functions, limits, derivatives, integrals, and infinite series and has widespread applications in science, engineering, economics, finance, statistics, and actuarial and biological science. The development of calculus in the seventeenth and eighteenth centuries was motivated by the need to understand physical phenomena such as the tides, the phases of the moon, the nature of light, gravity, etc.

Course Objectives:

- Learn the general concept of function and its applications to real-world situations.
- Explore the concepts, properties, and aspects of the differential and integral calculus of single variable functions.
- Learn the concepts of the derivative and its underlying concepts such as limits and continuity.
- Learn to calculate derivative for various type of functions using definition and rules.
- Learn about various application of derivatives to completely analyze and sketch the graph of a function, to solve applied derivative related problems, to solve applied minimum and maximum problems.
- Learn to work with exponential, logarithmic and trigonometric functions and their applications in applied problems.
- Learn about anti-derivative and the Fundamental Theorem of Calculus and its applications.
- Study of detailed methods for integrating functions of certain kinds.
- Understanding the techniques of integration and using them to solve the real-life oriented problems such as length, geometric area and volume, and surface areas.

Course Contents:

Differential Calculus: Limit, continuity and differentiability; differentiation of explicit and implicit functions and parametric equations; significance of derivatives; differentials; successive differentiation of various types of functions. Leibnitz's

theorem; Rolle's theorem; mean value theorems; Taylor's theorem in finite and infinite forms; Maclaurin's theorem in finite and infinite forms; Langrange's and Cauchy's form of remainder; expansion of functions by differentiation and integration; partial differentiation; Euler's theorem; Two variables, tangent, normal, subtangent and subnormal in Cartesian and polar coordinates. **Integral Calculus:** Definitions of integration; integration by method of substitution; integration by part; standard integrals; integration by the method of successive reduction; definite integrals with its properties and use in summing series; Wallis's formulae; improper integrals; Beta function and Gamma function; area under a plane curve in Cartesian and polar coordinates; area of the region enclosed by two curves in Cartesian and polar coordinates.

Course Learning Outcomes (CLO):

On completion of this course students will be able to:

CLO 1. understand the basic concepts and principles as well as geometrical meaning of differential and integral calculus of single variable functions.

CLO 2. evaluate limits, derivatives, limits in indeterminate formsand apply the derivatives to analyze and sketch the graph of various algebraic and transcendental functions.

CLO 3. apply the definition of continuity to pure and applied mathematics problems.

CLO 4. recognize increasing, decreasing functions and find maxima and minima, critical points and inflection points of functions and to determine the concavity of curves.

CLO 5. findasymptotes and sketch geometric curves and convert Cartesian coordinates in polar coordinate and find the polar equations of conics.

CLO 6. know standard indefinite integrals and evaluate integrals by substitution, by partial fractions, and by parts.

CLO 7. understand the concept of definite integral and know the fundamental theorem of calculus and use it for evaluating definite integrals including the evaluation of improper integrals.

CLO 8. calculate the area of regions in the plane, the volume and surface area of solids of revolution and Arc length of curves.

Mapping of CLO with PLO:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X	X									
CLO 3	X	X		X							
CLO 4	X	X		X							
CLO 5	X	X									
CLO 6	X										
CLO 7	X	X		X							
CLO 8	X	X		X							

Books Recommended:

1. L. I. Holder: *Calculus and Analytic Geometry*
2. Willerd Stephen: *Calculus and its Application*
3. Peter O' Neil: *Advanced Engineering Mathematics*
4. Thomas Finney*: Calculus*
5. James Stewart: *Differential Calculus*
6. James Stewart: *Integral Calculus*
7. Das and Mukherjee: *Differential Calculus*
8. Das and Mukherjee: *Integral Calculus*

Course Title: Physics I	Year/Semester:1/1	Course Status: Theory (Compulsory, Non-major)
Course Code: PHY 103E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite:		

Rationale

This is an introductory course in physics introducing basic terms, mathematical problems and related design concepts.

Course Objectives are

- to facilitate necessary knowledge about Newtonian mechanics and problem-solving technique.
- to accumulate basic ideas on waves behavior and Fourier theorem.
- to make the students understand the basic principles of thermodynamics.
- to get knowledge on the radiation.

Course Contents:

Mechanics:

1. Determination of moment of inertia of a flywheel.
2. Determination of "g" by and moment of inertia of a compound pendulum.

Properties of matter:

3. Determination of Young's Modulus by the method of bending.
4. Determination of Rigidity Modulus by Static method.
5. Using a flat spiral spring: a) Verification of Hooke's Law and determination of stiffness constant; b) Determination of "g" and the effective mass of the spring; c) Determination of modulus of rigidity of the material of the spring.

Electricity:

6. Determination of galvanometer resistance by half deflection method

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	explain conservation of mechanical energy for a system undergoing both rotational and translational motions, and find the moment of inertia of uniformly shaped, rigid body.
CLO 2	interpret load versus strain graphs and perform calculations for elastic moduli.
CLO 3	describe the elastic deformations of materials needed in our daily life.
CLO 4	determine the value of acceleration due to gravity "g" by using a compound pendulum from the measured time period and compare the predicted result with the published data.
CLO 5	determine the resistance of a galvanometer, understand the functions of various electrical components used in the experiment and construct electrical circuit based on the circuit diagram.
CLO 6	calculate the percentage and standard errors using the error analysis rules.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X										
CLO 5	X				X						
CLO 6	X				X						

Recommended Books

1. Worsnop, B.L. and Flint, H.T.: *Advanced Practical Physics*
2. Chowdhury, S. A. and Basak, A. K.: *Byaboharik PadarthaBidya*
3. Ahmed, G. and Uddin, M. S.: *Practical Physics*

Course Title: Physics I Lab	Year/Semester:1/1	Course Status: Lab (Compulsory, Non-major)
Course Code: PHY 104E	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: None		

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in PHY 103E.

Course Objectives are

- to facilitate necessary knowledge for carrying out some fundamental experiments of physics.
- to understand and verify some basic laws of physics.
- to find out the values of some physical parameters reflecting the properties of materials by performing experiments.

Course Contents:

Mechanics:

1. Determination of moment of inertia of a flywheel.
2. Determination of "g" by and moment of inertia of a compound pendulum.

Properties of matter:

3. Determination of Young's Modulus by the method of bending.
4. Determination of Rigidity Modulus by Static method.
5. Using a flat spiral spring: a) Verification of Hooke's Law and determination of stiffness constant; b) Determination of "g" and the effective mass of the spring; c) Determination of modulus of rigidity of the material of the spring.

Electricity:

6. Determination of galvanometer resistance by half deflection method

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	explain conservation of mechanical energy for a system undergoing both rotational and translational motions, and find the moment of inertia of uniformly shaped, rigid body.
CLO 2	interpret load versus strain graphs and perform calculations for elastic moduli.
CLO 3	describe th e elastic deformations of materials needed in our daily life.
CLO 4	determine the value of acceleration due to gravity "g" by using a compound pendulum from the measured time period and compare the predicted result with the published data.
CLO 5	determine the resistance of a galvanometer, understand the functions of various electrical components used in the experiment and construct electrical circuit based on the circuit diagram.
CLO 6	calculate the percentage and standard errors using the error analysis rules.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X								
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5			X	X							
CLO 6			X								

Recommended Books

1. Worsnop, B.L. and Flint, H.T.: *Advanced Practical Physics*
2. Chowdhury, S. A. and Basak, A. K.: *Byaboharik PadarthaBidya*
3. Ahmed, G. and Uddin, M. S.: *Practical Physics*

Course Title: History of the Emergence of Independent Bangladesh	Year/Semester:1/1	Course Status: Theory (Compulsory)

Course Code: SSS 100	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

This is a special compulsory course for all students of Bachelor program of Shahjalal University of Science and Technology, Sylhet. This course deals with the interrelated themes and topics that are essential to understand the emergence of Bangladesh.

Course Objectives are

The objective of this course is to make students understand about the causes of liberation war, rising of Bengali nationalism and identity, feelings of victory of Bangladesh. The specific course objectives are:

01. Give an outline about the concept of liberation war and freedom fighter.
02. Clarify the role of different people in liberation war.
03. Explain the role of Bangabandhu in liberation war.
04. Develop an insight about the value of the sacrifice of martyrs for motherland.

Course Contents:

1. Description of the country and its people

a. Impact of Geographical features
b. Ethnic composition of Bangladesh
c. Development of Bengali Language and its impact
d. Cultural syncretism and religious tolerance
e. Distinctive identity of Bangladesh in the context of undivided Bangladesh

2. Proposal for undivided sovereign Bengal, the partition of the Subcontinent, 1947 and Foreshadowing Bangladesh

a. Rise of communalism under the colonial rule, Lahore Resolution 1940
b. The proposal of Suhrawardi and Sarat Bose for undivided Bengal : consequences
c. The creation of Pakistan 1947
d. Foundation of Awami Muslim League and Foreshadowing Bangladesh

3. Pakistan: Structure of the state and disparity

a. Central and provincial structure
b. Influence of Military and Civil bureaucracy
c. Economic , social and cultural disparity

4. Language Movement and quest for Bengali identity

a. Misrule by Muslim League and Struggle for democratic politics
b. The Language Movement: context, phases and International Recognition of Bengali Language
c. United front of Haque – Vasani – Suhrawardi: election of 1954, consequences

5. Military rule: the regimes of Ayub Khan and Yahia Khan (1958-1971)

a. Definition of military rules and its characteristics

b. Ayub Khan's rise to power and characteristics of his rule (Political repression, Basic democracy, Islamisation)
c. Fall of Ayub Khan and Yahia Khan's rule

6. Rise of nationalism and the Movement for self-determination

a. Resistance against cultural aggression and resurgence of Bengali culture
b. Sheikh Mujibur Rahman and the 6 points movement
c. Reactions : Importance and significance
d. The Agortola Case 1968

7. The mass- upsurge of 1969 and 11 point movement

a. Background
b. Programme
c. Significance

8. Election of 1970 and its Impact

a. Legal Framework Order (LFO)
b. Programe of different political parties
c. Election result and centres refusal to comply

9. Non-cooperation Movement and 7th March Speech, 1971

a. The non-cooperation movement
b. Speech of 7th March : Background of the speech, major characteristics of the speech,
c. impact of this speech
d. International recognition of 7th March Speech as part of world heritage

10. Declaration of Independence of Bangladesh

a. Operation Searchlight
b. Declaration of Independence of Bangladesh by Bangobondhu
c. Beginning of the Liberation War of Bangladesh

11. The war of Liberation 1971

a. Genocide, repression of women, refugees
b. Formation of Bangladesh government and proclamation of Independence
c. The spontaneous early resistance and subsequent organized resistance (Mukti Fouz, Mukti Bahini, guerillas and the frontal warfare)
d. Publicity Campaign in the war of Liberation (Shadhin Bangla Betar Kendra, the Campaigns abroad and formation of public opinion)
e. Contribution of students, women and the masses (Peoples war) and different political parties
f. The role of Great powers and the United Nations in the Liberation war
g. The contribution of India in the Liberation War
h. The Anti-liberation activities of the occupation army, the Peace Committee, Al-Badar, Al-Shams, Rajakars, pro Pakistan political parties and Pakistani Collaborators , killing of the intellectuals
i. Trial of Bangabandhu and reaction of the World Community
j. Formation of joint command and the Victory
k. The overall contribution of Bangabandhu in the Independence struggle

12. The Bangabandhu Regime 1972-1975

a. Homecoming; Speech of 10 January
b. Making of the constitution
c. Reconstruction of the war-ravaged country
d. Foreign Policy of Bangabandhu; Bangabandhu's First Speech in the United Nations
e. The murder of Bangabandhu and his family and the ideological turn-around

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	1. Know liberation war of Bangladesh and role of freedom fighters
CLO 2	2. Know the causes of developing movement and nationalism
CLO 3	3. Know different disparities and deprivation of Bangladesh by Pakistan
CLO 4	4. Know the declaration and continuing breathtaking moments of liberation war.
CLO 5	5. Know the lifelong contributions of of Bangabandhu Shekh Mujibor Rahman in the creation of independent Bangladesh.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X									X
LO 2											
CLO 3										X	X
CLO 4		X									X
CLO 5		X						b	X	X	X

Recommended Books

1. Ahmed, Salahuddin and Bazlul Mobin Chowdhury (eds.), *Bangladesh: National Culture and Heritage: An Introductory Reader* (Dhaka: Independent University Bangladesh, 2004)
2. Harun-or-Roshid, *The Foreshadowing of Bangladesh: Bengal Muslim League and Muslim Politics, 1906-1947* (Dhaka : The University Press Limited, 2012)
3. Jahan Rounaq,*Pakistan: Failure in National Integration,(Dhaka :* The University Press Limited, 1977)
4. Maniruzzaman Talukder, *Radical Politics and the Emergence of Bangladesh, (Dhaka :* Mowla,Brothers, 2003)
5. Muhith, A M A,*History of Bangladesh: A Subcontinental Civilization*, (Dhaka: UPL, 2016)
6. Samad Abdus, *History of Liberation War of Bangladesh*, (Dhaka : Aparajeyo Bangla Prakashani, 2019)
7. Milton Kumar Dev, Md. Abdus Samad, *History of Bangladesh* (Dhaka : Biswabidyalya Prokasoni, 2014)
8. Schendel, Willem van : *A History of Bangladesh* (Cambridge: Cambridge University Press, 2009)

৯. শেখ মুজিবুররহমান : *অসমাপ্তআত্মজীবনী, (*ঢাকা :দি ইউনিভার্সিটি প্রেসলিমিটেড, ২০১২)

১০. নীহাররঞ্জনরায় : *বাঙালীরইতিহাস, (*কলকাতা : দে' জ পাবলিশিং, ১৪০২ সাল)

১১. সালাহ্উদ্দিনআহমেদ ও অন্যান্য (সম্পাদিত),*বাংলাদেশের মুক্তি সংগ্রামেরইতিহাস* ১৯৪৭-১৯৭১, (ঢাকা : আগামীপ্রকাশনী, ২০০২)

১২. আবুলমালআবদুলমুহিত : *বাংলাদেশ: জাতিরাষ্ট্রের উদ্ভব, (ঢাকা :* সাহিত্য প্রকাশ, ২০০০)

১৩. সিরাজুলইসলাম (সম্পাদিত), *বাংলাদেশেরইতিহাস ১৭০৪-১৯৭১,* ৩ খন্ড, (ঢাকা : এশিয়াটিক সোসাইটি অব বাংলাদেশ, ১৯৯২)

১৪. হারুন-অর-রশিদ :*বঙ্গীয় মুসলিম লীগ পাকিস্তান আন্দোলন বাঙালির রাষ্ট্রভাবনা ও বঙ্গবন্ধু,* (ঢাকা : অন্য প্রকাশন, ২০১৮)

15. হাসান হাফিজুর রহমান : *বাংলাদেশেরস্বাধীনতাযুদ্ধদলিলপত্র,*(সম্পাদিত), (ঢাকা: গণপ্রজাতন্ত্রীবাংলাদেশসরকার, ১৯৮৫)

১৬. সৈয়দ আনোয়ার হোসেন : *বাংলাদেশের স্বাধীনতাযুদ্ধে পরাশক্তির ভূমিকা,*(ঢাকা :ডানা প্রকাশনী, ১৯৮২)

১৭. মুনতাসীর মামুন ও অন্যান্য, *স্বাধীনবাংলাদেশেরঅভ্যুদয়ের ইতিহাস,* (ঢাকা: সুবর্ণ, ২০১৭)

১৮. আবুমো দেলোয়ার হোসেন, *স্বাধীনবাংলাদেশের অভ্যুদয়ের ইতিহাস,* (ঢাকা : বিশ্ববিদ্যালয়প্রকাশনী, ২০১৪)

১৯. আশফাক হোসেন, *স্বাধীনবাংলাদেশেরঅভ্যুদয়ের ইতিহাস,* (ঢাকা: প্রতিশূণ্য প্রকাশন, ২০১৯)

২০. আবুমো দেলোয়ার হোসেন, *বাংলাদেশের ইতিহাস, ১৯০৫-১৯৭১,*

২১. আশফাক হোসেন : *বাংলাদেশেরমুক্তিযুদ্ধ ও জাতিসংঘ,* (ঢাকা: বাংলাএকাডেমি, ২০০৩)

২২. আবু মো. দেলোয়ার হোসেন, ড. মোহাম্মদ সেলিম (সম্পাদনা) : *বাংলাদেশ ও বহির্বিশ্বে, (*ঢাকা : বাংলাদেশ ইতিহাস সমিতি, ২০১৫)

২৩. আশফাক হোসেন, *বাংলাদেশের মুক্তিযুদ্ধ ও ইন্দ্রিরা গান্ধী* (ঢাকা : সুবর্ণ প্রকাশনী, ২০১৭)

Course Title: Electrical Circuit II	Year/Semester:1/2	Course Status: Theory (Compulsory, Major)
Course Code: EEE 123	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 121 (Electrical Circuits I)		

Rationale:

This course helps students EEE students in gaining a broad idea of single and three phase power systems with various resistive and reactive loads. Using the basic concepts taught in Electrical Circuits I, this course provides knowledge about the relationship between real, apparent and reactive power - including the use of phasor and impedance diagrams, methods of measuring power, calculation of power factor.

Course Objectives are

1. To familiarize the students with the basic concepts related to measurement of voltage, current, power and phase shift in AC power circuits.
2. To teach the modeling and analysis of single phase RLC circuits for impedances, voltages, currents, powers and phase shift.
3. To make students understand phase rotation and Wye/Delta connections in 3-phase systems.
4. To teach the analysis of 3-phase RLC circuits (balanced and unbalanced) for impedance, voltage, current, power (P, Q and S), phase shift and power factor
5. To make the students understand the methods of determining appropriate components for power factor correction in power systems.
6. To teach the students the ways to apply Wye/Delta transformations and network theorems for the analysis of AC circuits.

Course Contents:

Sinusoidal Waveforms: Introduction to sinusoidal functions, phase relations, Instantaneous current, voltage, power, effective and average values of current and voltage.

The Basic Elements and Phasors: Response of basic elements to sinusoidal voltage and current, frequency response of the basic elements,average power, phasors and complex quantities, impedance, real and reactive power, power factor.

Series/Parallel AC circuits: Series and parallel RL, RC and RLC circuits.

Methods of Analysis: Series and parallel RL, RC and RLC circuits, nodal and mesh analysis, application of network theorems in AC circuits, circuits with non-sinusoidal excitations, transients in AC circuits, passive filters.

Resonance in AC circuits: Series and parallel resonance, selectivity and quality factor.

Analysis of three phase circuits: Three phase supply, balanced and unbalanced circuits, and power calculation.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand and explain the basic circuit concepts and responses.
CLO 2	Calculate the real, reactive and apparent power of AC networks.
CLO 3	Model and analyze single phase RLC circuits for impedances, voltages, currents, powers and phase shift.
CLO 4	Apply the transformation techniques and network theorems to facilitate necessary knowledge to analyze AC circuits and networks.
CLO 5	Design components for power factor correction in power systems.
CLO 6	Analyze various three phase circuits.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1											
CLO 2	X										
CLO 3		X									
CLO 4				X							
CLO 5	X								X		
CLO 6	X										

Recommended Books

1. Alternating Current Circuits by Russel M. Kerchner, George F. Corcoran
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
4. Networks, lines and fields by J. D. Ryder

Course Title: Electrical Circuit II Lab	Year/Semester:1/2	Course Status: Lab (Compulsory, Major)
Course Code: EEE 124	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 123 (Electrical Circuits II)		

Rationale

EEE students need to have a broad idea of single and three phase power systems with various resistive and reactive loads. They should also know the relationship between real, apparent and

reactive power - including the use of phasor and impedance diagrams, methods of measuring power, calculation of power factor. The theoretical knowledge is incomplete without hands on

experiments using the basic components and measuring devices. This course is designed to complement the theoretical course EEE 123.

Course Objectives are

1. Acquaint students with the basic circuit theorems.
2. Helping the students to develop ability in building AC electrical circuits and perform experiments on them.
3. To make the students understand the mechanism of power transmission.
4. To teach the analysis of three phase circuits.
5. To teach students the analysis of analyze resonant circuits.

Course Contents:

1. To be familiar with the operation of different electrical instruments.
2. To verify the following theorems:
   i) Superposition theorem
   ii)Thevenin's theorem
   iii) Norton's theorem
   iv) Maximum power transfer theorem and
   v) KCL and KVL theorem
3. To design and construct of low pass and high pass filter and draw their characteristics curves.
4. To investigate the voltage regulation of a simulated transmission network.
5. Study the characteristics of Star-Delta connection
6. Study the frequency response of an RLC circuit and find its resonant frequency.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain and apply basic circuit theorems.
CLO 2	Describe the mechanism of power transfer through transmission line.
CLO 3	Assess problems as a team effectively
CLO 4	Differentiate series and parallel resonant circuits.
CLO 5	Analyze three phase circuits.
CLO 6	Implement AC electrical circuits on breadboard and perform measurements with electronic test equipment.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X	X							
CLO 2			X	X							
CLO 3							X				

CLO 4			X	X							
CLO 5	X										
CLO 6	X										

Recommended Books

1. Alternating Current Circuits by Russel M. Kerchner, George F. Corcoran
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Fundamentals of Electric Circuits by Charles K. Alexander and Matthew N.O. Sadiku
4. Networks, lines and fields by J. D. Ryder

Course Title: Physics II	Year/Semester:1/2	Course Status: Theory (Compulsory, Non-major)
Course Code: PHY 207E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

This is an introductory course in physics introducing optics, electromagnetism, and modern physics concepts.

Course Objectives *are*

- to provide fundamental knowledge of Optics, including nature and propagation of light, interference of light, diffraction, polarization of light and apply the knowledge in their related field.
- to facilitate necessary knowledge about electricity and magnetism and to apply this knowledge to a wide variety of important application.
- to accumulate basic ideas of modern physics.

Course Contents:

Optics: nature and propagation of light, interference of light: Young's experiment, Newton's ring, Michelson interferometer, diffraction**:** Fraunhofer and Fresnel diffraction, diffraction grating, Polarization of light, optical activity, polarimetry.

Electromagnetism: different electrical units, Coulomb's law, electric field, Gauss's law and its applications, electric potential and potential energy, capacitance, dielectrics and Gauss's law, three electric vectors, energy storage in an electric field.

Faraday's law of induction, Lenz's law, time-varying magnetic field, inductance, energy in magnetic field.

Maxwell's equations, EM energy, Poynting vector, scalar and vector potentials, the wave equations, plane EM waves in non-conducting media, waves in conducting media, boundary conditions, reflection and refraction at boundaries of two non-conducting media, total internal reflections.

Modern Physics:atomic models, Bohr's atom, atomic spectra, photoelectric effect, Compton effect, X-rays, Bragg's law, atomic nucleus, nuclear forces, radioactivity, de Broglie wave, uncertainty principle.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	understand the theoretical concepts of light.
CLO 2	develop skills for solving problems using knowledge of interference and diffraction of light.
CLO 3	understand the polarization of light and apply the idea to measure optical activity.
CLO 4	apply basic principle of electricity and calculate current and voltage drop from circuit problem
CLO 5	design electric circuits for various devices.
CLO 6	understand the basic knowledge of electromagnetism with different laws and apply them to solve related problem.
CLO 7	interpret the phenomena of Modern Physics and know the approach of quantum theory.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X										
CLO 5	X				X						
CLO 6	X				X						X
CLO 7	X										X

Recommended Books

1. Halliday, D. and Resnick, R.: *Physics* (Vol. II)
2. Lipson, S. G. and Lipson, H.: *Light*
3. Jenkins, W.A. and White, H.A.: *Fundamentals of Optics*
4. Griffith, D.J.: *Introduction to Electrodynamics*
5. Beiser, A.: *Concepts of Modern Physics*

Course Title: Physics II Lab	Year/Semester:1/2	Course Status: Lab (Compulsory, Non-major)
Course Code: PHY 204E	Credits:1.5	Contact hours: 3 hours lab per week
Pre-requisite: None		

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in PHY 207E.

Course Objectives are

- to acquaint students with the basic principles of mechanics, waves, thermodynamics, and electricity through experiments and exercises.
- to understand the proper use of equipment and collection, presentation, and interpretation of data in an orderly manner.

- to develop skills for solving problems, calculating error in experiments, and finding techniques to minimize such error.
- to adapt a student as a member of a lab group, respecting and assisting all fellow members of the group.

Course Contents:

1. Determine the surface tension of water by the capillary rise method (height versus radius curve is to be drawn).
2. Determine the surface tension and angle of contact of mercury by Quincke's method.
3. Draw (-M) curve for both transverse and longitudinal waves by the Melde's apparatus and find the frequency of the vibrating rod.
4. Determine the thermal conductivity of the material of the given disc by lee's method.
5. Determine the value of low resistance by the resistance by the method of fall of potential.
6. Determine the temperature coefficient of the resistance of a copper coil.
7. Determine the cost of using an electrical bulb (Time will be specified).
8. Determine the relationship between the current through and potential across a carbon and a tungsten lamp.
9. To determine the value of acceleration due to gravity by Kater's pendulum.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	collect, present, and interpret experimental data in an orderly manner.
CLO 2	demonstrate problem-solving skills and techniques to identify and minimize experimental error.
CLO 3	determine the acceleration due to gravity and the surface tension of water and mercury.
CLO 4	determine the thermal conductivity and the temperature coefficient of the resistance of copper.
CLO 5	calculate the value of low resistance and the relationship between electric current and potential.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	LO 9	PLO 10	PLO 11
CLO 1			X	X							
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5			X								

Recommended Books

1. Worsnop, B.L. and Flint, H.T.: *Advanced Practical Physics*
2. Chowdhury, S. A. and Basak, A. K.: *Byaboharik PadarthaBidya*
3. Ahmed, G. and Uddin, M. S.: *Practical Physics*

Course Title:	Year/Semester:1/2	Course Status: Theory (Compulsory,

Chemistry		Non-major)
Course Code: CHE 101E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

This is a basic course on Chemistry to familiazrize students with the basic concepts.

Course Objectives are to familiarize the students with the basic concept of electronic structure

- Acquire the knowledge about the properties of elements on the periodic table
- Understand the concept of chemical formula and equation
- Acquire the basics of acid-base concepts and apply them to identify different acids and bases
- Understandgaseous state of matter and their properties
- Introduce preliminary ideas of chemical equilibrium and kinetics
- Acquaint students with the fundamentals of organic chemistry

Course Contents:

Atoms, molecules and ions: Atomic Theory, components of atoms.
Electronic Structure: Quantum theory, atomic spectrum of hydrogen and the Bohr model, Quantum numbers, Concept of Energy levels and atomic orbital, Electronic configuration, Chemical bonding and molecular structure.
The periodic Table: Development of the periodic table, Electron arrangements and the periodic table, Summarized chemical properties of s-block, p-block, d-block and f-block elements.
Chemical formulas and equations: Types of formulas, Percent composition from formula, Formulas from experiment, Formulas of ionic compounds, Names of compounds, Writing and balancing chemical equations, Mass relations in reactions, Limited reactant and theoretical yield. Concept of mole, Solution: Different concentration units.
Acids and Bases: Theories and Modern definition of acids and bases, Dissociation constant, strength, pH, Buffer solution etc.
Gaseous state: Measurement on gases, the ideal gas law, Volumes of gases involved in reactions, Gas mixtures, Partial pressure, Kinetic theory of gases, Real gases.
Introduction to Chemical Kinetics: Rate laws, rate constant, equilibrium constant, order of reaction etc.
Organic Chemistry: Introduction**,** Classification, Nomenclatures and Properties (Physical & Chemical) of (i) Aliphatic and aromatic hydrocarbons, (ii) Carbonyl compounds, (iii) Carboxylic acids and (iv) Carbohydrates (mono- and disaccharides).

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Classify elements, correlate atomic models, orbit & orbitals, electron distribution & energy level, hydrogen spectral series etc.
CLO 2	Apply different principles to determine the configuration for any atom or ion
CLO 3	Explain the development of the periodic table of elements,analyze and

	compare periodic trends in physical and chemical properties of elements in periodic table
CLO 4	Identify and explain the metallic and non-metallic characters of elements across the periodic table
CLO 5	Calculate the percent composition of a compound and derive empirical formulas from experimental data
CLO 6	Understand the concept and use of different concentration unit, limiting reactant and percent of yield
CLO 7	Define and apply the modern concepts of acids and bases to identify and classify the acids and bases and their strength and explain acidic and basic properties of species
CLO 8	Understand the ideal gas laws and its application on real system
CLO 9	Calculate volume, pressure, and temperature of gases based on the ideal gas laws
CLO 10	Understand the relationship between chemical kinetics and equilibrium
CLO 11	Name and understand the proper structure of different organic compounds
CLO 12	Predict physical and chemical properties of different organic compounds

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									
CLO 4	X										
CLO 5	X			X	X						
CLO 6	X	X									
CLO 7	X										
CLO 8	X										
CLO 9	X										
CLO 10	X										
CLO 11	X										
CLO 12	X										

Recommended Books

01. S. Z. Haider, *Introduction to Modern Inorganic Chemistry.*
02. Haque and Mollah, *Physical Chemistry*
03. R. T. Morrison and R. N. Boyd, *Organic Chemistry* (6th edition)
04. Raymond Chang, *General Chemistry*

Course Title: Chemistry Lab	Year/Semester:1/2	Course Status: Lab (Compulsory, Non-major)
Course Code: CHE 102E	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: None		

Rationale

This is a bsic lab course to familiarize students with the basic experiments in chemistry.

Course Objectives are to

- Make the students skilled for the theoretical and practical knowledge
- Make them able to perform the qualitative analysis of inorganic salts

Course Contents:

Qualitative analysis of inorganic salts:

- Separation and identification of group I cations
- Separation and identification of group II cations
- Separation and identification of group IIIA and IIIB cations
- Separation and identification of group IV cations
- Separation and identification of group V cations
- Identification of anions

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Identify analytical group cations in the solution of inorganic salt
CLO 2	Design an analytical scheme to separate and identify the known ions from a mixture of inorganic salts
CLO 3	Apply designed analytical scheme to separate and identify the unknown ions from a mixture of inorganic salts

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X	X	X						
CLO 2				X	X						
CLO 3				X	X						

Recommended Books

1. Vogel, *Qualitative Inorganic Analysis*
2. A.I. Vogel, *A Text Book of Practical Organic Chemistry*
3. A.I. Vogel, *Elementary Practical Organic Chemistry* (Part 1)
4. Vogel, *Text book of Quantitative Analysis.*

Course Title: Computer Aided Engineering Drawing	Year/Semester:1/2	Course Status: Lab (Compulsory, Non-major)
Course Code: ARC 108E	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: None		

Rationale

This course intends to train students to apply digital tools for engineering drawings and develop representation skills using computer aided software such as AutoCAD.

Course Objectives are

- to Help the students to understand the basic knowledge of engineering drawing
- to provide the knowledge of the use of engineering drawing in the field of electrical engineering.
- acquaint students with the basic tools of computer aided drafting using AutoCAD software.
- to help students to apply the knowledge through collaboration or teamwork.

Course Contents:

Basic concepts and the use of engineering drawing in the design and manufacturing field of electrical engineering. Develop an understanding of 2D and 3D computer aided drafting with the requirements of good engineering drawings and be able to apply them to their work. Appropriate sketching exercises will be done during practice hours by using a package program namely AutoCAD.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	learn the symbol of different electrical fixtures in a building
CLO 2	operate AutoCAD software using basic drawing commands
CLO 3	draw the electrical layout of a room
CLO 4	design electrical layout of a building
CLO 5	place lighting fixtures appropriately in a building
CLO 6	work as a team in different multidisciplinary projects

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X		X								
CLO 3			X								
CLO 4			X	X							
CLO 5			X	X							
CLO 6			X				X				

Recommended Books

1. Bernd S. Palm: Introduction to AutoCAD 2020: 2D and 3D Design
2. Munir Hamad: AutoCAD 2020, Beginning and Intermediate.
3. Pradeep Mamgain: Autodesk 3Ds Max 2020: A Detailed Guide to Modeling, Texturing, Lighting, and Rendering, 2nd Edition.

Course Title: Co-ordinate Geometry and Linear Algebra	Year/Semester:1/2	Course Status: Theory (Compulsory, Non-major)
Course Code: MAT 103E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale: This course is designed to cover the fundamental properties of linear algebraic structures such as the algebra of matrices, vector space, and inner product space.

Course Objectives:

- To provide expertise on common matrix operations including cofactor expansions and row reductions, and applying these tools in calculating determinant, rank, inverse, and echelon forms of matrices.
- To make students able to investigate the consistency of a system of linear equations and to choose an appropriate method to find the solution of a given system of linear equations.
- Acquaint students with the fundamental properties of vector spaces and subspaces including null space and column space, and their bases and dimensions.
- To facilitate students understand the properties of linear transformations, transformation matrices and their changes for a given basis with respect to the standard basis of a vector space.
- To make students able to find the characteristic polynomial, eigenvalues, associated eigenvectors, and the diagonalized matrix of a transformation matrix.
- To facilitate students to understand inner product spaces, orthogonal vectors, orthonormal bases,and orthogonalization processes.

Course Contents:

Coordinate geometry: Coordinate geometry of two dimensions: Change of axes; transformation of co-ordinates; pair of straight lines; general equation of second degree. Coordinate geometry of three dimensions: System of co-ordinates; distances of two points; section formula; projection; direction cosines; equations of planes and straight lines. **Matrix:** Matrix and matrix operations; different types of matrices; algebraic operations on matrices; cofactors and minors; determinant of a square matrix; adjoint and inverse of a matrix; elementary transformation of matrices; normal and canonical form of a matrix; rank of a matrix; the row-reduced form of a matrix and rank;equivalent systems of linear equations; the general solution of a system of linear equations; homogeneous systems;eigenvalues and eigenvectors; diagonalization of matrices. **Vector space:** Vector spaces and subspaces; linear dependence and independence; spanning set and basis; coordinates and dimension; null space, row space and column space; change of basis. **Linear transformations:** Linear transformations; composition of transformations; matrix representation; change of basis; diagonalization representation of a linear transformation by a diagonal matrix; the eigenvalues and eigenvectors of a symmetric matrix; quadratic form; functions of a square matrix. **Inner product spaces:** Definition and examples; Cauchy-Schwartz inequality; orthogonality; orthonormal basis and Gram-Schmidt process.

Course Learning Outcomes (CLO):

By the end of this course the students will be able to:

CLO 1. calculate the determinant, rank, inverse, and echelonforms of a given matrix by using the cofactor expansion methodor the row reduction method.

CLO 2. investigate the nature of the solution of a systemof linear equations and find the solution of a given system of linear equations by choosing an appropriate method.

CLO 3. testthe independence of vectors and find the dimension and basis of a given vector space and its subspaces.

CLO 4. find the matrix representing a linear transformation under a given basis and observe how the matrix changes if the basis is changed.

CLO 5. determine the eigenvalues, associated eigenvectors, diagonalization, and different factorizations of a transformation matrix.

CLO 6. determine orthogonal vectors and orthonormal basis, apply the Gram-Schmidt orthogonalization process, and understand the bilinear and quadratic forms.

Mapping of CLO with PLO:

CLO/PLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X	X								
CLO 2	X	X	X	X							
CLO 3	X	X									
CLO 4	X	X		X							
CLO 5	X	X									
CLO 6	X	X									

Books Recommended:

1. Howard Anton and Chris Rorres: *Elementary linear algebra applications*
2. Steven J. Leon: *Linear algebra with applications*, Prentice Hall, 1998
3. Rahman and Bhattacharjee: *Co-ordinate geometry of two and three dimensions*
4. Loney, S. L.: *Coordinate Geometry of Two dimensions*
5. Golub, Van Loan: *Matrix Computation*

Course Title: Principles of Economics	Year/Semester:1/2	Course Status: Theory (Compulsory, Non-major)
Course Code: ECO 105E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

This ECO 105 course provides an introduction to the main ideas and concepts involved in modern economics and attempts to provide students with an understanding of how the economy works, what type of problems economists attempt to solve, and how they set about trying to solve them. The course is primarily concerned with the analysis of individual decision-making agents, the behaviour of firms and industries in the economy (microeconomics), on the economy as a whole (macroeconomics) and the inherent problems facing underdeveloped and developing countries (economic development).

Course Objectives:

Microeconomics part provides a brief and simple introduction to the subject matter and scope of Economics. This section aims to provide an introduction to microeconomic analysis. It outlines the theory of markets with relevant applications to business, social and individual issues. The course covers the principles and consequences of "rational" choice by individual economic agents in markets. The course also provides an introductory analysis of the role of governments in seeking to ensure the efficient operation of markets.

Macroeconomics section provides a brief and simple introduction to the subject matter and scope of Macroeconomics. It also aims to provide an introduction to macroeconomic analysis outlining how the national income is measured and determined. It also provides a framework in which the interaction of money and goods and services markets can be developed, allowing students to understand the process by which the levels of economic activity, employment are determined.

Economic development section provides students with an understanding of economic theories and analysis in the field of development economics. The section is designed to deal with a selection of issues and problems facing the developing economies.

Course Contents:

Introduction to Microeconomics: Definition and scope; basic concepts and tools—PPF and circular flow model; fundamental economic problems and solution systems; Concepts of demand, supply and equilibrium; Concepts of elasticity, different types of elasticities, their applications; Concepts of total and marginal utility; Concepts of production, cost and profit, characteristics of different types of markets.

Introduction to Macroeconomics: Key macroeconomic indicators and their performance measurement - GNP, GDP, inflation, unemployment; money, functions of money, function of commercial and central bank, monetary policy; fiscal policy and structure of govt. budget.

Development and related issues: Growth and development; concept of poverty and poverty measures; HDI; key human-socio-economic development indicators of Bangladesh, Sustainable Development Goals (SDG).

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand the analysis of individual decision-making agents, the behaviour of firms and industries in the economy
CLO 2	Understand the concept of elasticity quantitatively and qualitatively in economic analysis and know differences between different types of markets ;
CLO 3	Explain macroeconomic concepts and use simple economic models to interpret the behaviour of key macroeconomic variables;
CLO 4	Understand monetary and fiscal policy and Government budget;

CLO 5	Understand the main issues confronting underdeveloped and developing countries.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X										
CLO 4	X	X			X						
CLO 5		X			X						X

Recommended Books

1. Arnold, R. A. (2014): Economics, South Western Publishing Company, Eleventh Edition
2. Bangladesh Economic Review relevant issues.
3. Mankiw, N. G. (2012): Principles of Economics, Thomson South Western Publishing, Sixth Edition
4. Samuelson, P. A. and Nordhaus,W. D. (2009): Economics, McGraw-Hill USA, Nineteenth Edition.
5. Todaro, M. P. and Smith,S. C. (2012): Economics of Development in the Third World, Longman, Eleventh Edition

Second Year

Course Title: Electronics I	Year/Semester:2/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 221	Credits: 3	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 123 (Electrical Circuits II)		

Rationale:

Analogue circuits are integral parts of any electronic system. Analogue circuits consist of transistors and diodes in addition to resistors, capacitors and inductors often in an integrated circuit form. In previous courses, students were introduced to circuit analysis and synthesis techniques involving passive circuit elements. This course endeavors to build on this knowledge and further expand students' skill in analyzing and designing analogue circuits involving transistors and diodes. The course covers: the basic principles of operation and device characteristics of diodes, Bipolar Junction Transistors, Junction Filed Effect Transistors and Metal Oxide Semiconductor Field Effect Transistors underpin the analysis, design and implementation of analogue circuits. Multi-stage amplifiers using transistors further enhanced the course. Upon completion, students should be able to construct, analyze, verify, and troubleshoot analog circuits using appropriate techniques and test equipment.

Course Objectives are:

- To make the students acquainted with the semiconductor theory.
- To introduce the basic principle operations, device and circuit characteristics of diodes and BJT JFET and MOSFET transistors.
- To make the students understand the basic concept of biasing and apply proper biasing according to the application.
- To facilitate necessary knowledge about analysis and design of analogue circuits such as amplifiers.
- To introduce the idea about DC and AC analysis of different amplifier circuits.
- To familiarize the students with the important parameters that define the response of analog circuits

Course Contents:

P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode, simplified DC and AC diode models, dynamic resistance and capacitance.

Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor, characteristics of a Zener diode, Zener shunt regulator, clamping and clipping circuits.

Bipolar Junction Transistor (BJT) as a circuit element: Current components, BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch.

Single stage mid-band frequency BJT amplifier circuits: Voltage and current gain, input and output impedance of a common base, common emitter and common collector amplifier circuits.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Structure and physical operation of an enhancement MOSFET, threshold voltage, Body effect, current-voltage
characteristics of an enhancement MOSFET, biasing discrete and integrated MOS amplifier circuits, single-stage MOS amplifiers, MOSFET as a switch, CMOS inverter.

Junction Field-Effect-Transistor (JFET): Structure and physical operation of JFET, transistor characteristics, pinch-off voltage. Differential and multistage amplifiers: Description of
differential amplifiers, small-signal operation, differential and common mode gains, RC coupled mid-band frequency amplifier.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the theoretical principles essential for understanding the operation of electronic circuits
CLO 2	Interpret and analyze the device characteristics of diodes, BJT, MOSFET and JFET.
CLO 3	Distinguish different types of transistor biasing techniques and apply proper biasing to ensure the correct operation of the transistor networks.
CLO 4	Determine appropriate parameters to define the response of analog circuits.
CLO 5	Design and analyze single and multi-stage amplifier using BJT, MOSFET and JFET.

CLO 6	Recognize the need for and demonstrate the ability to engage in life-long learning to apply the most advanced electronic technologies to design energy efficient circuits.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X			X						
CLO 3		X		X							
CLO 4		X		X							
CLO 5				X				X			
CLO 6				X						X	

Recommended Books

1. Microelectronic Circuit by Adel Sedra, K.C. Smith
2. Electronic Devices and Circuit Theory by Robert L. Boylestad
3. Electronics Principles. By Malvino

Course Title Electronics I Lab	Year/Semester:2/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE 222	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 122 (Electrical Circuits II Lab)		

Rationale:

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-221. Theoretical knowledge is incomplete without hands on experiments using

the basic components and measuring devices. This is an introductory experimental laboratory that explores the design, construction, and debugging of analog electronic circuits. Lectures and two laboratory projects investigate the performance characteristics of diodes, transistors, JFETs, and MOSFETS, including the construction of a small audio amplifier and preamplifier. The course provides opportunity to simulate real-world problems (as given as assignment) and solutions that involve tradeoffs and the use of engineering judgment.

Course objectives are:

- Acquaint students with the basic idea about implementing different types diode circuits and investigate the voltage, current relationships.
- To help the students to develop ability to verify the theoretical concepts through laboratory and simulation experiments.
- To provide the knowledge about the procedure of determination of voltage gain, current gain, overall gain in a single and multistage BJT, JFET and MOSFET amplifiers.
- To provide the students with the capability of implementing different real life analog electronic circuits.

Course Contents:

1. The study of V-l Characteristics curve of P-N junction diode.
2. The study of Half-Wave and Full Wave Rectification circuit.
3. The study of Clipping and clamping circuits.
4. Measurement of the voltage regulation Zener diode circuits.
5. The study of operation of BJT and analyze the characteristics curve
6. Study of the DC analysis of BJT amplifier circuit: Different biasing circuits and determination of the best biasing circuit.
7. Calculate the voltage gain, current gain of a multistage BJT amplifier circuit
8. Study of the operation of JFET and analysis of the characteristics curve.
9. Study of the DC analysis of JFET amplifier circuit: different biasing circuits and investigates the best biasing circuit.
10. Calculation of the voltage gain, current gain of a multistage JFET amplifier circuit.
11. The study of operation of MOSFET and analysis of the characteristics curve.
12. Calculation of the voltage gain, current gain of a multistage MOSFET amplifier circuit.
13. Implementation the BJT and MOSFET switching network.
14. Students will be assigned real-life hardware/software-based projects.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	identify the characteristics of electronic circuits and present experimental results in order to reach a valid conclusion about the behavior of circuits.
CLO 2	compute the main parameters of electronic circuits to facilitate necessary knowledge to analyze circuit performance.
CLO 3	assemble simple analogue electronic circuits.
CLO 4	solve problems, starting from the acquired knowledge essential for the design of economically feasible electronic circuits.
CLO 5	comply with ethical values for collecting and documenting experimental data.
CLO 6	develop the ability to work as a part of the team to achieve specified and measurable results while performing the experiments.
CLO 7	formulate the ability to communicate individual opinion effectively across the members of the team.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X		X							
CLO 2		X		X							
CLO 3			X	X							
CLO 4		X		X					X		
CLO 5							X	X		X	
CLO 6						X	X				
CLO 7						X	X				X

Recommended Books

1. Microelectronic Circuit by Adel Sedra, K.C. Smith
2. Electronic Devices and Circuit Theory by Robert L. Boylestad
3. Electronics Principles. By Malvino
4. **Lab Manual:** Will be supplied by course teacher in the beginning of the course and also available in website.

Course Title: Electrical Machines I	Year/Semester: 2/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 223	Credits: 3.0	Contact hours: 3 hours Lecture per week
:Pre-requisite: EEE 121 (Electrical Circuits I) , EEE 123 (Electrical Circuits II)		

Rationale:
Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. Generation of electricity includes electric
machineries. So student should have insight knowledge of how electric machineries works and how to handle them. This course examines the basic theory, characteristics, construction operation and application of rotating electrical machines. It includes the study of poly-phase induction motors and transformer.

Course objectives are:
- To teach the construction, characteristics, operation and application of A.C. rotating and standstill electrical machines.
- To help the students develop skills to solve magnetic circuit problems using formulae, certain Laws (Faraday, Lenz) and Rules (Fleming).
- To help the students develop skills to solve problems relating to generated voltage, terminal voltage, currents, load power factors, input and output power, efficiency, and voltage regulation in transformers.
- To help the students develop skills to solve problems relating to synchronous speed, slip, rotor frequency, rotor voltage, rotor current, torque, developed power, efficiency and power factor in poly-phase induction motors.
- To provide the knowledge to explain the results of laboratory tests on various rotating and static electrical machines under load conditions.
- Helping the students to develop ability in safely wire and operate electrical rotating machines and their associated metering and starting equipment.
- To describe the design of major classes of electric machines

Course Contents:
Transformer: Ideal transformer- transformation ratio, no-load and load vector diagrams; actual transformer- equivalent circuit, regulation, short circuit and open circuit tests. Three phase induction motor: Rotating magnetic field, equivalent circuit, vector diagram, torque-speed characteristics, effect of changing rotor resistance and reactance on torque-speed curves, motor torque and developed rotor power, no-load test, blocked rotor test, starting and braking and speed control. Single phase induction motor: Theory of operation, equivalent circuit and starting.

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Understand the transformer operating principle.
CLO 2	Identify the inadequacies of Transformers and how to reduce them.
CLO 3	Describe three phase power distribution system.
CLO 4	Explain induction motor design and working principle.
CLO5	Compute transformer parameters theoretically and practically.
CLO 6	Calculate induction motor parameters theoretically and practically.
CLO 7	Apply measures for efficient operation of electrical machines.
CLO 8	Formulate proper procedure for speed control, starting and braking.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2		X		X							
CLO 3	X			X							
CLO 4	X							X			
CLO 5				X				X			
CLO 6				X				X			
CLO 7		X								X	
CLO 8		X						X	X		

Recommended Books:
1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta

Course Title: Electrical Machines I Lab	Year/Semester: 2/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE 224	Credits: 1.5	Contact hours: 3 hours of lab per week
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 123 (Electrical Circuits II)		

Rationale:
Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. Generation of electricity includes electric machineries. So student should have insight knowledge of how electric machineries works and how to handle them. The theoretical knowledge is incomplete without hands on
experiments using the basic components and measuring devices used in Energy Conversion. This course is designed to complement the theoretical course EEE 223.

Course objectives are:
- To facilitate necessary knowledge about different AC machines and skills to handle various lab apparatus.
- Acquaint students with voltage transformation ratio and turn ratio of transformer and experience their importance.
- Helping the students to develop ability in examining the effect of resistive, inductive and capacitive loading of single phase transformer.
- To provide the knowledge of calculating different transformer parameters without actually loading the transformer.
- Foster the analytical knowledge to calculate different AC asynchronous motor parameters without actually loading the motor.

Course Contents:

1: Familiarization with the lab, its equipment and laboratory regulation.
2: Determination of voltage transformation ratio and turn ratio of a single phase transformer.
3: Determination of regulation and efficiency with resistive, inductive and capacitive loading of a single phase and three phase transformer.
4: Short circuit and open circuit of single phase transformer.
5: No load test and blocked rotor test of three phase induction motor.
6: Three phase induction motor speed control and drawing torque-speed curve.
7: Single phase capacitor-run induction motor speed control.

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the safety procedures for high voltage electrical machines.
CLO 2	Identify and interpret different electrical machines.
CLO 3	Implement circuits to calculate transformer and induction motor parameters practically.
CLO 4	Illustrate equivalent circuit of transformers and induction motors from experiments.
CLO 5	Operate induction motor speed control techniques.
CLO 6	Design efficient ways for machine operation.
CLO 7	Develop the ability to work as a part of the team to achieve specified and measurable results while performing the experiments.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X	X							X	
CLO 2		X	X					X			
CLO 3				X				X			
CLO 4	X			X							
CLO 5				X				X			
CLO 6		X		X					X		
CLO 7						X	X				

Recommended Books:
1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta

Course Title: Signals and Linear Systems		Year/Semester:2/1	Course Status: Theory (Compulsory, Major)
Course Code:EEE 231	Credits: 3.0	Contact hours: 3 hours lecture per week	
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 123 (Electrical Circuits II),			

Rationale

This course aims to introduce students to the basic concepts of signals and linear systems in continuous time domain, in preparation for more advanced courses like Digital Signal Processing, Communication Theory, and Control System Engineering. The course is a special one in the sense that it is the very basic course that helps one persuade higher learning in the field of Communication & Signal Processing; just like the Electronics I and II courses for Electronics majors and Machine I and II courses for Power majors. Understanding of the course material is very important for those who wish to work in future in fields like machine vision, artificial intelligence and audio, video and image processing.

Course Objectives are
- To learn about classifications of signals, common signal definitions, properties of signals,
- To learn about classifications of systems, common system definitions, properties of systems,
- To provide knowledge about Fourier series representation of periodic and Fourier transform of aperiodic signals and its use in analysis of continuous time signals and systems.
- To help students developing basics of Laplace Transform and its use in analysis of continuous time signal and systems.
- To apply the theoretical concepts in various problem solving like stability criteria determination, electrical circuit modeling, solving differential equations etc.

Course Contents:
Continuous-time signals and systems: Mathematical, frequency and time domain representation. Discrete-time signals and systems: Mathematical, frequency and time domain representation, Application in digital processing and communication systems. Linear Systems: Characteristics of a linear system, methods of transient and steady state solutions of differential and integro-differential equations, Network theorems, Analogous systems. Analysis by Fourier methods. Laplace transformation and its application to linear circuits. Impulse function, convolution integral and its application. Matrix with simple applications in circuits: network functions, poles and zeroes of a network. Introduction to topological concepts in electrical and magnetic circuit networks.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Define common signals and explain the basic operations of signals.
CLO 2	Classify systems based on their properties, understand the properties as well as analysis and design implications for system interconnections in time domain.
CLO 3	Calculate correlation, convolution, and orthogonality of signals. Fourier series; analyzing Fourier spectra, effect of symmetry.
CLO 4	Analyze Fourier series, Fourier spectra, effect of symmetry, Fourier Transform
CLO 5	Interpret and illustrate Fourier transformed magnitude and phase spectra for aperiodic/periodic case.

CLO 6	Determine Laplace transform; interpret & plot magnitude and phase spectra.
CLO 7	Apply Laplace transform for solution of different problems.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X			X							
CLO 3	X				X						
CLO 4	X				X			X			
CLO 5	X			X							
CLO 6	X										
CLO 7		X		X					X		

Recommended Books

1. Signals & Linear Systems-B.P. Lathi
2. Continuous and Discrete Signals and Systems-Samir S Soliman and MAndyam D Srinath.

Course Title: Numerical Analysis Lab	Year/Semester:2/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE 210	Credits: 1.0	Contact hours: 2 hours lab per week
Pre-requisite: MAT 101E		

Rationale:

This course introduces students to numerical methods for the solution of basic mathematical problems that cannot be solved by hand. The course aims to introduce students to the toolbox of widely-used numerical methods in computational science. Students will be able to apply these methods to problems in a variety of sciences.

Course objectives are:

- To teach the numerical methods used in computational science
- To teach to apply numerical methods to problems in practice.
- To familiarize with, use, and understand software which uses numerical methods
- To introduce with the role of numerical methods in science
- To engage in scientific and technical communication

Course Contents:

Numerical analysis: Errors in numerical calculations. **Error:** Definitions, sources, examples. Propagation of Error. Ageneral error formula. **Root finding:** The bisection method and the iteration method, the method of false position. Newton-Raphson method. **Methods of approximation theory:** Polynomial interpolation: Lagrange form, divided formula for interpolation. **Solution of systems of Linear equations:** Gaussian elimination. The pivoting strategy, Iteration method solution of tridiagonal systems. **Numerical solution of ordinary differential equations:** Euler's method (including modified form), Rnge-Kutta method. **Numerical Integration :** Trapezoidal method. Simpson's method. Weddle's method; Eigen value problems for matrices, Use of computer to implement projects in numerical methods.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Perform an error analysis for a given numerical method by going through the stages (mathematical modeling, solving and implementation) of solving a particular physical problem
CLO 2	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
CLO 3	Apply numerical methods to obtain approximate solutions to mathematical problems.
CLO 4	Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
CLO 5	Analyze and evaluate the accuracy of common numerical methods.
CLO 6	Implement numerical methods using contemporary technology
CLO 7	Construct efficient, well-documented code and present numerical results in an informative way.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X			X							
CLO 2		X		X							
CLO 3		X		X							
CLO 4				X	X						
CLO 5					X						
CLO 6		X							X		
CLO 7								X			

Recommended Books

1. Numerical Methods for Engineers - Steven C. Chapra, Raymond P. Canale.
2. Introduction to Numerical Analysis - F.B. Hildebrand.

Course Title: Cost and Management Accounting	Year/Semester:2/ 1	Course Status: Theory (Compulsory, Non-major)
Course Code: BUS 243E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

It is a basic course on business principles and cost management

Course Objectives are

1. To describe the cost concepts, cost behaviour, and cost accounting techniques that are applied to manufacturing and service businesses.
2. To be capable to interpret cost accounting statements,
3. To provide the students with the capability to apply theoretical knowledge in decision making.
4. To be able to analyse and evaluate information for cost ascertainment, planning, control of business operations.
5. To discuss the various techniques available to measure managerial performance and to motivate employees toward organizational goals.
6. To identify and analyse both qualitative and quantitative standards to formulate best control methods

Course Contents:

Introduction to Cost Accounting: Definition of Cost Accounting, Comparison of Cost Accounting and Financial Accounting; The role of Cost Accounting; Methods and Techniques of Cost Accounting; Characteristics of an Ideal Cost Accounting System.

Cost Concepts, Classifications and Statements: Cost Object; Expenditures, Cost, Expense and Loss; Cost Classifications; Cost Data and Uses; The Chart of Accounts; Statement of Cost of Goods Manufactured and Sold; Cost Statement or Cost Sheet.

Costing and Control of Materials: Classification of Materials; Accounting for Materials; Store ledger(FIFO & WAM) method; Inventory Planning; Ordering Cost, Holding Cost and EOQ; Effect of Quantity Discounts on EOQ; Safety Stock and Reorder Point; Material Control Methods; Materials Requirement Planning System. Practical problem.

Costing and Control of Labour: Productivity and Labour Costs; Costs included in Labour; Accounting for Labour; Time Keeping, Computation of total payroll and Allocation of Payroll costs; Different incentive plan; Labour cost Control, Labour Turnover and Control of Labour Turnover; Learning Curve Theory. Practical problem & solution

Costing and Control of Manufacturing Overhead: Manufacturing Overhead Costs; Actual Vs. Normal Costing of Manufacturing Overhead; Production Capacity, Predetermined Overhead Rates; Departmental vs. Plant-wise Overhead Rates; Separating Mixed Costs. Scatter-graph; High-low Method and Regression Analysis; Accounting for Manufacturing Overhead; Analysis and Disposition of Under-applied-and Over-applied Overhead

Contract Costing: Determination of profit of completed and incomplete contracts.

Cost Terms, Concepts and Classifications: Cost Behaviour (Analysis and Use): General cost classifications- product costs versus period costs- cost classifications on Financial Statements. Types of cost behaviour patterns- the Analysis of Mixed Costs, High-low method

Cost-Volume-Profit Relationships: The basics of CVP analysis- Break -even analysis- Break-even chart- Sales Mix. Business application and mathematical problem of CVP analysis

Budget: Define Budget, Types of Budget, Cash budget, purchase budget, sales budget, flexible budget and related problems

Standard Costing: Meaning and Objectives- Types of ratios. Standard Costing and its uses for making business decision. Variance calculation, Decision making process from these calculations.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	use cost accounting for decision making and performance evaluation.
CLO 2	demonstrate how materials, labor and overhead costs are added to a product at each stage of the production cycle.
CLO 3	express the place and role of cost accounting in the modern economic environment.
CLO 4	recognize and apply the skills necessary for carrying out effective management decision-making and strategic management planning;
CLO 5	select the costs according to their impact on business and society.
CLO 6	interpret the impact of the selected costs method.
CLO 7	design management control process in different business areas.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X								X	
CLO 2		X							X	X	X
CLO 3									X		X
CLO 4						X	X	X	X	X	
CLO 5		X									X
CLO 6		X									X
CLO 7									X	X	X

Recommended Books

1. Cost Accounting –Volume-1 by Basu and Das;
2. Managerial Accounting by Ray H. Garrison, Eric W. Noreen
3. Cost Accounting by Mutz Uzry et al

Course Title: Vector Analysis and Complex Variables	Year/Semester:2/1	Course Status: Theory (Compulsory, Non-major)
Course Code: MAT 201E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: MAT 101E		

Rationale: This course is designed primarily for those students taking courses in mathematics, physics, mechanics, electromagnetic theory, aerodynamics, geophysics, metrology or any of the numerous other fields in which vector methods are applicable. Vector algebra have become basic part of fundamental mathematical background required of those in engineering, sciences and allied disciplines. In complex variable part, the students will learn algebra and geometry of complex numbers, mappings in the complex plane, the calculus of functions of single complex variable, analyticity of a complex function, theory of multi-valued functions, contour integrations and some properties of complex mappings.

Course Objectives:

- Introduce students to the fundamentals of vector algebra.
- Expose students to mathematical applications of vector and tensor algebra to handle diverse problems which occur in real life situations.
- Perform basic mathematical operations (arithmetics, powers, roots) with complex numbers in Cartesian and polar forms.
- Determine limits/continuity/differentiability/analyticity of a function and find the derivative of a function.
- Work with functions (polynomials, reciprocals, exponential, trigonometric, hyperbolic, etc) of single complex variable and describe mappings in the complex plane.
- Work with multi-valued functions (logarithmic, complex power) and determine branches of these functions.
- Determine the number of singularities, zeros of a polynomial in the unit disk and in the right half plane.
- Evaluate a contour integral using parametrization, fundamental theorem of calculus and Cauchy's integral formula.
- Basic concepts of the complex sequences and infinite series. Find the Taylor series and Laurent series of a complex function and determine its circle or annulus of convergence.
- Explain the concepts, state and prove theorems and properties involving the above topics.

Course Contents:

Vector Analysis: Definitions of line, surface and volume integrals; gradient of a scalar function; divergence and curl of a vector function; physical significance of gradient, divergence and curl - various formulae; integral forms of gradient; divergence theorem, Stoke's theorem, Green's theorem and Gauss's theorem. Complex Variable: Complex number system; general functions of a complex variable; limit and continuity of a function of complex variables and related theorems; complex differential and the Cauchy-Riemann equations; mapping by elementary functions; line integral of a complex function; Cauchy's integral formula; Liouville's theorem; Taylor's and Laurent's theorem; singular points; residue; Cauchy's residue theorem; evaluation of residues; contour integration; conformal mapping.

Course Learning Outcomes (CLO):

By the end of this course the students will be able to

CLO 1. understand vector and tensor algebra and its applications in applied sciences and engineering.

CLO 2. know the fundamental mathematics of vector and tensor that are important for higher learning.

CLO 3. provide working tools for students in some branches of applied mathematics, physics and geophysics.

CLO 4. develops ability to solve mathematical problems involving vectors.

CLO 5. competently use vector algebra as a tool in the field of applied sciences and related fields.

CLO 6. perform basic mathematical operations and prove basic properties of complex numbers in Cartesian form using complex arithmetic and complex conjugates to fine comparison with limits/continuity/differentiability between real valued function and complex valued function.

CLO 7. know about analyticity, different types of singularities, application of Taylor series expansion.

CLO 8. able to kwon the residue of a function and use the residue, applications of related theorems in complex plane and evaluate a contour integral or an integral over the complex plan.

CLO 9. adept about conformal mappings, bilinear transformations and their properties and finally, comparison all the applications with real analysis and complex analysis.

Mapping of CLO with PLO:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4			X								
CLO 5				X							
CLO 6				X							
CLO 7	X										
CLO 8	X										
CLO 9			X								

Books Recommended:

- M. R. Spiegel: *Vector Analysis*
- Churchill: *Introduction to Complex Variable and Applications*
- Macrobeat: *Complex Variable*
- Spiegel, M.R. *Complex Variable*

Course Title: Electrical Machines II	Year/Semester: 2/2	Course Status: Theory (Compulsory, Major)
Course Code: EEE 225	Credits: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 223 (Electrical Machines I)		

Rationale:
Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. Generation of electricity includes electric machineries. So student should have insight knowledge of how electric machineries works and how to handle them. This course examines the basic theory, characteristics, construction operation and application of rotating electrical machines. It includes the study of DC and AC machines.

Course objectives are:
- Help them conceptualize the construction, characteristics, operation and application of both DC and AC machines including dc motor, dc generator, alternator and synchronous motor.
- To develop skills on solving magnetic circuit problems using formulae, certain Laws (Faraday, Lenz) and Rules (Fleming).
- To enhance the skills on solving problems relating to generated voltage, terminal voltage, currents, torque, speed, input and output power, efficiency, and voltage/speed regulation in DC generators.
- To provide knowledge on solving problems relating to rotor speed, flux, torque, developed power, efficiency in DC motors.
- Facilitate necessary knowledge to solve problems relating to generated voltage, terminal voltage, current, frequency, load power factors, and synchronous impedance in poly-phase alternators.
- Accumulate basic ideas about synchronous speed, slip, rotor frequency, rotor voltage, rotor current, torque, developed power, efficiency and power factor in poly-phase synchronous motors.
- To provide students the basic knowledge to explain the results of laboratory tests on various rotating electrical machines under load conditions.
- Enhancing skills on safely wire and operate electrical rotating machines and their associated metering and starting equipment.
- To describe the design of major classes of electric machines.

Course Contents:
Synchronous Generator: excitation systems, equivalent circuit, vector diagrams at different loads, factors affecting voltage regulation, synchronous impedance, synchronous impedance method of predicting voltage regulation and its limitations. Parallel operation: Necessary conditions, synchronizing, circulating current and vector diagram. Synchronous motor: Operation, effect of loading under different excitation condition, effect of changing excitation, V-curves and starting. DC generator: Types, no-load voltage characteristics, build-up of a self-
excited shunt generator, critical field resistance, load-voltage characteristic, effect of speed on no-load and load characteristics and voltage regulation. DC motor: Torque, counter emf, speed, torque-speed characteristics, starting and speed regulation. Introduction to wind turbine generators.

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Understand three phase power generation and distribution system
CLO 2	Describe the three phase synchronous generator operating principle
CLO 3	Explain DC machine working principle.
CLO 4	Interpret synchronous generators voltage regulation on different loads
CLO 5	Compute DC machine parameters theoretically and practically.
CLO 6	Calculate electrical system's efficiency and improve it.
CLO 7	Design systems with parallelly connected generators.
CLO 8	Formulate proper procedure for speed control, starting and braking.
CLO 9	Differentiate between AC and DC machines.
CLO 10	Evaluate which machine is effective in different conditions.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X							X			
CLO 5				X							
CLO 6				X				X		X	
CLO 7				X				X			
CLO 8		X									
CLO 9	X										
CLO 10		X						X			

Recommended Books:
1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta
4. Electrical Machinery Fundamentals by Stephen J. Chapman

Course Title: Electrical Machines II Lab	Year/Semester: 2/2	Course Status: Lab (Compulsory, Major)
Course Code: EEE 226	Credits: 1.5	Contact hours: 3 hours of Lab per week
Pre-requisite: EEE 223 (Electrical Machines I), EEE 224 (Electrical Machines I Lab)		

Rationale:
Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. Generation of

electricity includes electric machineries. So student should have insight knowledge of how electric machineries works and how to handle them. The theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in Energy Conversion. This course is designed to complement the theoretical course EEE 225.

Course objectives are:

- To facilitate necessary knowledge about different DC and AC machines and handle various lab apparatus.
- To help students develop skills to control the speed of dc motor and observe the existence of back EMF.
- To describe the importance of residual magnetism on voltage build-up of dc generator.
- To help students develop skills to determine voltage regulation of dc generator.
- To provide the basic knowledge to obtain O.C.C and loading curve of synchronous generator.
- To provide the basic knowledge to obtain V-curve of synchronous motor.

Course Contents:

1: Familiarization with different electrical machines and components in an electrical system.
2: Speed control of DC shunt motor
3: Verify the existence of back EMF in a DC shunt motor.
4: Determining torque-speed characteristics of DC motor.
5: Determining voltage regulation of DC shunt generator.
6: No load and loading characteristics of synchronous generator.
7: Determining V-curve of synchronous motor.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the safety procedures for high voltage electrical machines.
CLO 2	Identify and interpret different electrical machines.
CLO 3	Implement circuits to calculate synchronous generators voltage regulation on different loads..
CLO 4	Calculate DC machine parameters theoretically and practically.
CLO 5	Interpret torque-speed characteristics of different machines.
CLO 6	Differentiate between AC and DC machines
CLO 7	Compare synchronous motor and machine V-curve
CLO8	Develop the ability to work as a part of the team to achieve specified and measurable results while performing the experiments.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1			X				X			X
CLO 2			X							
CLO 3				X				X		
CLO 4				X						
CLO 5				X				X	X	
CLO 6									X	
CLO 7				X						X
CLO 8						X	X	X		

Recommended Books:

1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta
4. Electrical Machinery Fundamentals by Stephen J. Chapman

Course Title: Electronics II	Year/Semester: 2/2	Course Status: Theory (Compulsory, Major)
Course Code: EEE 227	Credits: 3.0	Contact hours: 3 hours Lecture per Week
Pre-requisite: EEE 221 (Electronics I)		

Rationale:

This course is a continuation of Electronics I. The aim of this course is to introduce the students to the advanced concepts of electronics. The primary objective of this course is to understand and implement the advanced electronic circuits such as amplifiers, passive and passive and active filters, etc. with the help of theoretical and practical problem solving. In this course students will learn about 'Electronics' in regard to working principle, operational characteristics of operational amplifiers, oscillators, power amplifiers, feedback amplifiers and active filters. Various topics include transistor and Op-Amp circuits and extend to the frequency response of transistor

amplifiers and the use of cascaded amplifiers to increase gain and bandwidth. This course will not only give them basic knowledge about these basic devices but also will provide adequate knowledge about how to improve efficiency of the devices in different technology.

Course objectives are:

- To facilitate necessary knowledge to analyze amplifiers for frequency response.
- Acquaint students with the basic tools to identify, select and handle transistor and ICs for amplifier design.
- To help students develop understanding differential amplifiers.
- To facilitate necessary knowledge to analyze and design feedback circuits using op-amp.
- To facilitate necessary knowledge to analyze and design oscillator circuits using op-amp and other transistors.
- To provide basic knowledge about power amplifiers.

Course Contents:

Frequency response of amplifiers: Poles, zeros and Bode plots, amplifier transfer function, techniques of determining 3 dB frequencies of amplifier circuits, frequency response of single-stage and cascade amplifiers, frequency response of differential amplifiers.

Operational amplifiers (Op-Amp): Properties of ideal Op-Amps, non-inverting and inverting amplifiers, inverting integrators, differentiator, weighted summer and

other applications of Op-Amp circuits, effects of finite open loop gain and bandwidth on circuit performance, logic signal operation of Op-Amp, DC imperfections.

General purpose Op-Amp: DC analysis, small-signal analysis of different stages, gain and frequency response of 741 Op-Amp.

Negative feedback: properties, basic topologies, feedback amplifiers with different topologies, stability, frequency compensation.

Active filters: Different types of filters and specifications, transfer functions, realization of first and second order low, high and band pass filters using Op-Amps.

Signal generators: Basic principle of sinusoidal oscillation, Op-Amp RC oscillators, LC and crystal oscillators.

Power Amplifiers: Classification of output stages, class A, B and AB output stages.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the theoretical principles essential for understanding the operation of various amplifiers, filters and signal generators.
CLO 2	Understand the basic concept of feedback and distinguish the characteristics of differenttypes of feedback amplifiers.
CLO 3	Explain frequency response and stability of differential amplifiers
CLO 4	Describe the basics about power amplifiers.
CLO 5	Design proper and high efficiency amplifier in all frequency application (Single stage and multistage).
CLO 6	Analyze low order and high order active filters.
CLO 7	Model different signal generators using op-amp and other transistors.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									
CLO 4	X								X		
CLO 5		X		X					X		
CLO 6	X			X							
CLO 7				X							

Recommended Books

1. Microelectronic Circuit by Adel Sedra, K.C. Smith
2. Electronic Devices and Circuit Theory by Robert L. Boylestad
3. Electronics Principles. By Malvino
4. Operational Amplifier and Linear Integrated Circuits by Robert F. Coughlin, Frederick F. Driscoll

Course Title: Electronics II Lab	Year/Semester: 2/2	Course Status: Lab (Compulsory, Major)
Course Code: EEE 228	Credits: 1.5	Contact hours: 3 hours of lab per Week
Pre-requisite: EEE 221 (Electronics I), EEE 222 (Electronics I Lab),		

Rationale:

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-227. Theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices. This is an introductory experimental laboratory

that explores the design, construction, and analysis of amplifier in different frequency range, active filters and oscillators.

Course objectives are:

- To help students develop the ability to interpret the frequency response of single stage and cascaded amplifiers.
- To make students understand the basic properties of a non-ideal op-amp:741.
- To teach students the methods to design and observe characteristics of different component coupled amplifiers.
- To teach students the methods to design and observe characteristics of different types of filters.
- To teach students the methods to design and observe characteristics of different types of oscillators.

Course Contents:

1: Study of R-C coupling.
2: Study of Transformer coupling.
3: Study of Direct coupling.
4: Study of R-C Phase Shift Oscillator.
5: Study of Transistor Tuned Oscillator.
6: Study of Negative feedback circuit.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Determine the characteristics of electronic circuits and present experimental results.
CLO 2	Construct and analyze different types of amplifier and measure the performance parameters.
CLO 3	Design and analyze characteristics of various filters.
CLO 4	Analyze properties of different negative feedback circuit using op-amp.
CLO 5	Maintain ethics while collecting and documenting experimental data.
CLO 6	Develop the ability to work as a part of the team to achieve specified and measurable results while performing the experiments.
CLO 7	Formulate the ability to communicate individual opinion effectively across the members of the team.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1		X		X							
CLO 2				X							

CLO 3				X	X						
CLO 4				X							
CLO 5										X	
CLO 6							X				
CLO 7							X				

Recommended Books

1. Microelectronic Circuit by Adel Sedra, K.C. Smith
2. Electronic Devices and Circuit Theory by Robert L. Boylestad
3. Electronics Principles. By Malvino
4. Operational Amplifier and Linear Integrated Circuits by Robert F. Coughlin, Frederick F. Driscoll
5. **Lab Manual:** Will be supplied by course teacher in the beginning of the course and also available in website.

Course Title: Electromagnetic Fields and Waves		Year/Semester: 2/2	Course Status: Theory (Compulsory, Major)
Course Code: EEE 229	Credits: 3.0	Contact hours: 3 hours Lecture per week	
Pre-requisite: None			

Rationale:

This subject deal with the basic theory and practice relevant to all forms of electronic communications. Illustrative examples taken from conventional (RF, mobile, microwave, and
optical communications) and novel aspects of communications (radar, computer interconnections, mobile wireless systems, radio-telescopes, satellite communications etc.) will be given. This course will help students to have a basic knowledge of electromagnetics in a telecommunications context,
to know how to formulate and solve simple problems in electromagnetics and to gain an understanding of how other disciplines relate to the study of electromagnetics.

Course objectives are:

- To acquaint students with the properties of static electric field systems and methods to solve electrostatic problems.
- to accumulate basic ideas about the properties of static magnetic field systems and methods to solve magnetostatic problems.
- To understand basic electromagnetic induction theory and methods to solve related problems.
- To help students conceptualize Maxwell's equations and their use in deriving time harmonic wave equation.
- To facilitate necessary knowledge about electromagnetic wave propagation process in lossy and lossless medium & EM power flow.

Course Contents:

Review of Vector Algebra and Co-ordinate System: Curvilinear Co-Ordinates, Rectangular Cylindrical and Spherical Co-Ordinates, Gradient, Divergence, Curl and Formulas involving Vector Operations.

Electrostatics: Coulombs law, Gauss's theorem, Laplace's and Poisson's equations, Energy of an electrostatic system.

Magneto static: Ampere's law, Biot-Savart law, Energy of magneto static system. Maxwell's equations: Their derivations, Continuity of charges, Concept of displacement current, Electro-Magnetic Energy, Boundary conditions, The Wave Equations with Sources. Potentials used with varying charges and currents, Retarded potentials, Maxwell's equation in different co-ordinate systems.

Relation between circuit theory and field theory: Circuit concepts and the derivation from the field equations, high frequency circuit concepts, Circuit radiation resistance, Skin effect and circuit impedance, Concept of good and Perfect conductors and dielectrics, Propagation in good conductors, Reflection of uniform plane waves, standing wave ratio, Dispersion in dielectrics.

Propagation of electromagnetic waves: Plane wave propagation, Polarization, Power flow and pointing theorem, Transmission line analogy, Display lines ion in dielectrics, Liquids and solids.

Radio wave propagation: Different types of radio wave propagation Ionosphere, Vertical heights and critical frequencies of layers, Propagation of RW through Ionosphere, Reflection of RW, Skip distance and MUF, Fading, Static and noise, Two way communication.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Explain basics of orthogonal coordinate systems and vector properties.
CLO 2	Describe different laws of Elctrostatics and Magnetostatics like Gauss's law and Ampere's law.
CLO 3	Explain wave propagation through different mediums.
CLO 4	Understand electromagnetic waves travelling in transmission lines.
CLO 5	Explain the different ways of electromagnetic wave propagation through the atmosphere.
CLO 6	State the basic polarization concepts of electromagnetic wave.
CLO 7	Compute electromagnetic field quantities for various conditions.
CLO 8	Calculate the energy stored by static electric and magnetic fields.
CLO 9	Point out the importance of Maxwell's equations.
CLO 10	Calculate propagation delay, attenuation factor, skin depth, group velocity of waves in different mediums
CLO 11	Evaluate the Electromagnetic wave equation to interpret how electric and magnetic field coexists.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X				X						
CLO 2	X										
CLO 3	X				X						
CLO 4	X			X					X		

CLO 5	X								X		
CLO 6	X				X						
CLO 7		X		X							
CLO 8				X							
CLO 9	X				X						
CLO 10		X		X	X						
CLO 11	X				X						

Recommended Books:

1. Field and Wave Electromagnetic by David K. Cheng
2. Elements of Electromagnetics by Matthew N.O. Sadiku
3. Engineering Electromagnetics by William H.Hayt, John A. Buck

Course Title: Electrical Service Design	Year/Semester: 2/2	Course Status: Lab (Compulsory, Major)
Course Code: EEE 232	Credits: 1.5	Contact hours: 3 hours of Lab per Week
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 123 (Electrical Circuits II)		

Rationale:

Electrical services are a vital component in any building, so it is necessary for engineers to understand the basic principle of services design. This Course content includes the concepts of

wiring system design, various lighting schemes, design of substation layout of equipment and design of security systems. This course will help them to trouble shoot a design problem on a single/multi-storied building/structure.

Course Objectives are

- To train electrical/electronic engineers and equip them with appropriate knowledge and skills required for the lighting design, power supply design and their installations.
- To make the student suitable for starting out a career in electrical services design and installation within consultancy, contracting, and in-company design engineers.
- Provide students with opportunities to be conversant to the electrical/electronic codes and safeties regulating electrical/electronic activities locally and internationally.

Course Contents:

1. Wiring system design, Fitting and Fixture layout, Conduit layout, drafting, and estimation.
2. Design for illumination and lighting.
3. Electrical installations system design: substation, BBT and protection, heating and lifts.
4. Design for intercom, public address systems, telephone system and LAN.
5. Design of security systems including CCTV, fire alarm, smoke detector, burglar alarm, and sprinkler system.
6. A design problem on a single/multi-storied building/structure.
7. First Aid Equipment for earthquake or accident protection.
8. Air Conditioning, Refrigerator, Distribution Box Protection.

9. Three phase and single-phase design of clamp on meter for service.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand the basic concept of lighting design, power supply distribution design and installations in order to design an energy efficient and sustainable building.
CLO 2	Explain advantage of Security & Protection System.
CLO 3	Determine the professional scope of an electrical design project.
CLO 4	Interpret various components of the service design of the building that includes general and specialized loads, lighting systems and distribution systems and design the building according to the needs of the clients.
CLO 5	Use AutoCAD to draw/generate electrical/electronic engineering drawings.
CLO 6	Design substation layout of equipment and related installation of the equipment.
CLO 7	Practice the ethical, economic, societal, technical and environmental standards and regulations that guide the electrical design process.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X								X	
CLO 2		X								X	X
CLO 3									X	X	X
CLO 4	X			X							
CLO 5				X				X	X		
CLO 6				X						X	
CLO 7										X	X

Recommended Books

1. Electrical Wiring Estimating and Costing by S.L. Uppal and G.C.Grag

Course Title: Basic Statistics and Probability	Year/ Semester: 2/2	Course Status: Theory (Compulsory, Non-major)
Course Code: STA 202E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale

Acquiring knowledge on the statistical tools and techniques for exploring and analyzing the data.

Course Objectives are

- To learn to present data,
- To know descriptive statistical measures,
- To study probability and probability distributions,
- To understand Markov chain and queuing theory,

- To perform correlation and regression analysis.

Course Contents:
Frequency distribution of data: population and sample. Collection and representation of statistical data. Tabulation of data. Class intervals. Frequency distribution, discrete, continuous and cumulative distributions. Histograms and frequency polygons. Graphical representation of data. Statistical measures: measures of central tendency - arithmetic mean, median, mode, geometric mean, weighted average, harmonic mean. Measures of dispersion - range, standard deviation, variance, coefficient of variation, moments, skewness, kurtosis. Correlation theory: linear correlation. Measures of correlation and its significance. Regression and curve fitting: linear and non-linear regression. Methods of least squares. Curve fitting. Probability: definition of probability and related concepts. Laws of probability. Discrete and continuous random variables. Mathematical expectations. Conditional probability. Probability distributions: binomial, Poisson and normal distributions and their properties. Stochastic process. Markov chain (discrete and continuous). Queuing theory – birth and death process in queuing. Examples from computer science. Queuing models – elementary concepts.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Gather knowledge on types of data, scale of measurement, construction of frequency distribution, and graphical presentation of data;
CLO 2	Acquire knowledge on different measures of central tendency, dispersion and shape characteristics, and prove important theorems related to these measures;
CLO 3	Compute measures of central tendency, measures of dispersion and shape characteristics
CLO 4	Acquire basic concepts of probability
CLO 5	Acquire knowledge on random variable and its uses
CLO 6	Gain knowledge on the study of Binomial, Poisson and Normal distributions, solve problems on finding probabilities from these distributions
CLO 7	Gather knowledge on correlation and regression analysis
CLO 8	Familiarize with stochastic processes including Markov chain and queuing theory

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2					X						X
CLO 3	X										
CLO 4	X										
CLO 5	X	X									
CLO 6	X				X						
CLO 7	X				X						
CLO 8	X							X			

Recommended Books

1. Devore J., (2009), Probability and Statistics for Engineering and the Sciences, 8th Edition, Brooks/Cole, Cengage Learning, California
2. Montgomery, D.C., Runger, G.C., (2003), Applied Statistics and Probability for Engineers, 3rd Edition, John Wiley & Sons, Inc., NY
3. Ross, S.M., (2007), Introduction to Probability Models, 9th Edition, Academic Press, NY

Course Title: Ordinary and Partial Differential Equations	Year/Semester:2/2	Course Status: Theory (Compulsory, Non-major)
Course Code: MAT 203E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: MAT 101E, MAT 103E		

Rationale: This course provides introduction to ordinary and partial differential equations with applications. Topics include classification of, and what is meant by the solution of a differential equation, first-order equations for which exact solutions are obtainable, solution of initial value problems, explicit methods of solving higher-order linear differential equations, an introduction to systems of differential equations both homogeneous and non-homogeneous systems.

Course Objectives:
- Separable Differential Equations
- Linear and Non-Linear Differential Equations
- First- Order Differential Equations
- Solving Differential Equations using various Methods
- Solving systems of homogeneous and non homogeneous Differential Equations
- Use knowledge of partial differential equations (PDEs).
- Classify PDEs, apply analytical methods, and physically interpret the solutions.

Course Contents:
Ordinary Differential Equations: First and second order equations; Laplace transform solutions; Higher order equations;Second-order partial differential equations; Direction Fields; Solution of Some Differential Equations; Classification of Differential Equations.Second order linear differential equations: Homogeneous equations with constant coefficients; fundamental solutions of linear homogeneous equations; linear independence and the wronskian; complex roots of the characteristic equations; repeated roots; reduction of order; nonhomogeneous equations; method of undetermined coefficients; The Laplace transform: Definition of Laplace transform; solution of initial value problems; step functions; differential equations with discontinuous forcing functions; impulse functions. Systems of two linear differential equations: Introduction to systems of differential equations; introduction to 2x2 matrices; linear systems of differential equations. Nonlinear differential equations and stability: Phase portraits of 2x2 linear systems;

autonomous systems and stability; almost linear systems; predator-prey equations. Fourier series: the Fourier convergence theorem; even and odd functions.

Course Learning Outcomes (CLO):
By the end of this course the students will be able to:

CLO 1. understand about the concepts of differential equations, and it's various classifications.

CLO 2. Learn the types of solutions and several techniques to solve different kinds of differential equations as well as the graphical representations of the solutions.

CLO 3. analyze real world scenarios to recognize when ordinary and partial differential equations or systems of ODEs are appropriate, formulate problems about the scenarios, and creatively model these scenarios in order to solve the problems using multiple approaches.

CLO 4. work with ODEs and PDEs and systems and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics.

CLO 5. classify the fundamental principals of partial differential equations(PDEs) to solve hyperbolic, parabolic and elliptic equations.

Mapping of CLO with PLO:

CLO/ PLO	PL O1	PL O2	PL O3	PL O4	PL O5	PL O6	PL O7	PL O8	PL O9	PL O10	PL O11
CLO1	X	X		X							
CLO2	X	X		X							
CLO3	X	X	X	X							
CLO4	X	X		X		X					
CLO5	X	X		X							

Books Recommended:

1. W. E.Boyce and R.C. Diprima: *Elementary Differential Equations and Boundary Value Problems*
2. Daniel Kaplan, Leon Glass: *Understanding Nonlinear Dynamics*
3. Ross, S. L.: *Differential Equations*
4. Spiegel, M. R.:*Laplace Transform*

Third Year

Course Title: Digital Electronics	Year/Semester: 3/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 323	Credits: 3.0	Contact hours: 3 hours lecture per week

Pre-requisite: EEE 221 (Electronics I)

Rationale
The main aim of this course is to provide sound knowledge of the principles and practices of digital systems, both at the device and circuit level. The course covers topics in digital electronics including: Number Theory, Boolean Algebra, Logic Circuits, Logic Minimization Techniques, Multiplexers, Adders, Flip-Flops, Counters, Registers, State Machines, Memory Circuits, Digital / Analog Conversion, Programmable Logic Circuits and Microcomputer Bus Architecture. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment.

Course Objectives are
- To make students understand the fundamental principles in design and implementation of digital logic circuits including combinational circuits, sequential circuits, and finite state machines.
- To develop skills to perform decimal, octal, hexadecimal, and binary conversions.
- To provide the knowledge to apply Boolean algebra to solve logic functions.
- To help students in learning the analysis of pulse circuits.
- To develop skills for multiplexing digital circuits.
- Help students conceptualize with the basics of logic family.
- Make the students devise logic switching circuits.
- Accumulate the basic idea of memory storage devices.
- To acquaint students with the basic tools to plan and execute projects in digital circuits
- Foster the analytical and c ritical knowledge to develop logic design circuits with Programmable Logic Devices

Course Contents:
Introduction to number systems and codes, Boolean algebra, Basic gates and functions,
Combinational logic design: Power optimization of basic gates and combinational logic circuits. Modular combinational circuit design, multiplexer, demultiplexer, decoder, encoder, comparators, binary arithmetic elements and ALU design,
Sequential circuits: different types of latches, flip-flops, timing analysis and power optimization of sequential circuits, sequential logic design, modular sequential logic circuit design: shift registers, counters and their applications,
Logic devices: logic arrays, field programmable logic arrays and programmable read only memory, DC characteristics, noise margin and power dissipation, Logic families. Verilog HDL Basics.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain binary, octal, hexadecimal, BCD number systems
CLO 2	Reproduce logic expressions using binary Boolean algebra
CLO 3	Generate the prime implicates of logic functions of 5 or fewer variables using graphical (Karnaugh map) method, and to obtain their minimal

	two-level implementations with and without don't cares.
CLO 4	Analyze combinational circuits
CLO 5	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 6	Manipulate synchronous sequential circuits to extract next state/output functions
CLO 7	Translate a word statement specifying the desired behavior of a simple sequential system into a finite state machine (FSM), to simplify and build the architecture that consists of state register and next state/output logic
CLO 8	Apply simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									
CLO 4	X										
CLO 5	X										
CLO 6	X										
CLO 7	X	X									
CLO 8	X	X									X

Recommended Books

1. Digital Logic Design by Morris Mano
2. Digital Systems by Ronald Tocci, Neal Widmer, Greg Moss
3. Digital Principles and Applications by Donald P Lech, Albert Paul Malvino and Goutam Saha

Course Title: Digital Electronics Lab	Year/Semester: 3/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE 324	Credits: 1.5	Contact hours: 3 hours lab per
Pre-requisite: EEE 222(Electronics I Lab)		

Rationale

The main aim of this course is to provide practical knowledge of the principles and practices of digital systems, both at the device and circuit level. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean Algebra,Logic Circuits, Logic Minimization Techniques, Multiplexers, Adders, Flip-Flops, Counters, Registers, State Machines, Memory Circuits, Digital / Analog Conversion, Programmable Logic Circuits and Microcomputer Bus Architecture. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment.

Course Objectives are:

- Help students to conceptualize the fundamental principles in design and implementation of digital logic circuits including combinational circuits, sequential circuits, and finite state machines.
- To develop skills to perform decimal, octal, hexadecimal, and binary conversions.
- To provide the knowledge to apply Boolean algebra to solve logic functions.
- Accumulate the basics for multiplexing digital circuits.
- Acquaint the students with logic switching circuits and pulse circuits.
- Apply the knowledge of mapping memory storage devices.
- To acquaint students with the basic tools to plan and execute projects in digital circuits.
- To enhance the skills of logic design with Programmable Logic Devices.

Course Contents:

This course consists of two parts. In the first part, students will perform experiments to verify practically the theories and concepts learned in EEE-323. In the second part, students will design simple systems using the principles learned in EEE-323.

1. To construct and study the following logic gates: AND, OR, NOT. NAND, NOR, EXOR
2. Verify the DE Morgan's Law: Law(I) and Law(II)
3. To verify different kind of applications of Boolean algebra.
4. To construct an AND gate by diode resistors and observe its characteristics.
5. To verify the characteristics of Exclusive OR and Exclusive NOR using basic logic gate.
6. Verification of De-Morgan's Theorem for 2 input Variable.
7. To simplify the given Boolean function by using K-map and implement it with logic Diagram.
8. ABCD to 7 Segment Decoder
9. Study of 4-bit BCD adder.
10. Study of Asynchronous & Synchronous R-S Flip-Flop.
11. Study of J-K Flip-Flop.
12. Study of 4-bit binary Ripple Counter.
13. Verilog HDL Basics.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand and analyze combinational circuits
CLO 2	Generate the prime implicates of logic functions of 5 or fewer variables using graphical (Karnaugh map) method efficiency, and to obtain their minimal two-level implementations with and without don't cares.
CLO 3	Manipulate logic expressions using binary Boolean algebra
CLO 4	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 5	Analyze synchronous sequential circuits to extract next state/output functions

CLO 6	Translate a word statement specifying the desired behavior of a simple sequential system into a finite state machine (FSM), to simplify and build the architecture that consists of state register and next state/output logic
CLO 7	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life
CLO 8	Designing simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X		X	X	X						
CLO 2			X	X	X						
CLO 3	X	X	X	X							
CLO 4	X	X	X	X	X						
CLO 5	X	X	X	X	X						
CLO 6	X	X			X						
CLO 7						X	X	X	X	X	
CLO 8	X	X	X	X							X

Recommended Books

1. Digital Logic Design by Morris Mano
2. Digital Systems by Ronald Tocci, Neal Widmer, Greg Moss
3. Digital Principles and Applications by Donald P Lech, Albert Paul Malvino and Goutam Saha

Course Title: Power System I	Year/Semester: 3/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE325	Credit: 3.0	Contact hours: 3 hours Lecture
Pre-requisite: Pre-requisite: EEE 223 (Electrical Machines I), EEE 225 (Electrical		

Rationale:

Modern power systems have grown larger with many interconnections between neighboring power systems. This course will provide strong foundation in classical methods and modern techniques in power systems for senior level electrical engineering students.

Course objectives are:

- Acquaint students with basics of major types of components used in electrical power systems.
- To facilitate necessary knowledge to analyze different types of short-circuit faults.
- Get the basic ideas to calculate the steady-state power flow in a power system.
- Enhancing the skills to calculate the power system dynamics and its stability.
- Foster the analytical and critical knowledge to determine the economic dispatch in a power system.
- To provide knowledge of power system control.
- To provide knowledge of smart grid structure and operation.

Course Contents:

Representation of an Electric **Network:** One Line Diagram, Impedance and Reactance Diagrams.

Per Unit System: Basic idea about Per- unit system, Per-unit impedances in single phase Transformer circuits, Per-unit impedances in three phase Transformer circuits, Advantages of Per-unit computation**.**

Line Representation: Equivalent circuit of short, medium and Long lines. Interpretation of equations of long transmission line, Surge impedance loading, Hyperbolic form of the equation of long transmision line, Ferranti effect.

Load Flow Analysis: Bus Admittance matrix, Power flow equation, bus classification, Gauss Seidel Power flow solution, Line Flows and Losses, Newton-Raphson Method.

Control of power flow: Prime mover and excitation control of generators, Control of tap-changing transformers,phase shifting, booster and regulating transformer, Switching of shunt capacitor banks, Power factor correction/ Improvement.

Fault Analysis: Short circuit current and reactances (transient, subtransient and synchronous) of a synchronous machine, Internal voltages of loaded machine under transient conditions, Short Circuit Capacity (SCC).

Symmetrical Components: Positive, negative and zero sequence components, Three-phase complex power in terms of symmetrical components, Sequence impedance, Determination of sequence impedance matrix, Drawing positive, negative and zero sequence networks.

Unsymmetrical Faults: Single Line to Ground fault (L-G), Line to Line fault (L-L), Line to Line to Ground fault (L-L-G), Line to Ground Fault(L-G) through and impedance at the terminal of an unloaded generator, Line to Line(L-L) fault through and impedance at the terminal of an

unloaded generator, Double Line to ground (L-L-G) fault through an impedance at the terminal of an unloaded generator.

Protection: Introduction to relays, differential protection and distance protection, introduction to circuit breakers.

Typical layout of a substation: Variable Load on Power Station: Structure of Electric Power System, Variable Load on Power System, Load Curves, Important Terms & Factors: Demand Factor, Diversity Factor, Load Factor, Capacity factor, Plant Factor, Units Generated per annum, Load Duration Curves, Types of load. Unit Commitment and Optimization.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Understand power system networks and different types of faults occurred in power system.
CLO 2	Identify faults, remove faults and predict them.
CLO 3	Explain power plant parameters for operation and expansion.
CLO 4	Apply methods to control real and reactive power flow.
CLO 5	Analyzing symmetrical and unsymmetrical system faults.
CLO 6	Design an efficient power system network.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X										
CLO 4	X	X									X
CLO 5	X	X									
CLO 6	X	X							X		X

Recommended Books:

1. Power System Analysis by John J. Grainger, William D. Stevenson, Jr
2. Principle of Power System by V.K. Mehta
3. Power System Analysis by Hadi Sadat

Course Title: Power System I Lab	Year/Semester: 3/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE-326	Credit: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 224 (Electrical Machines I Lab), EEE 226 (Electrical Machines II Lab)		

Rationale:

Proper planning, operation and control of large power systems require advanced computer based techniques. This lab course includes five experiments and two practice sessions to study various aspects of power systems.The course will train students with modern computer-based techniques for solving a wide range of power system problems, which includes load flow, balanced and unbalanced faults and transient stability analyses.

Course objectives are:

- Allow students to practically verify several basic concepts and procedures learned in power system modeling and analysis.
- To develop hands-on experience of how certain procedures of power system operation are carried out.
- Help students carry out system studies using state of the art power systems analysis software to assess system operation in steady state and under faulted conditions.

Course Contents:

1: To get familiar with Power World -17 Simulator
2: Computing Bus Admittance Matrix Y bus.
3: Investigate the reactive power compensation in power grid.
4: Jacobian matrix and power-flow solution by Newton–Raphson.
5: Symmetrical Fault Analysis.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Identify faults, remove faults and predict them in the power system network
CLO 2	Implement one line diagram power system networks.
CLO 3	Calculate Bus Admittance and Impedance Matrix using laboratory apparatus
CLO 4	Apply methods to control real and reactive power flow.
CLO 5	Analyzing symmetrical and unsymmetrical system faults
CLO 6	Develop the ability to work as a part of the team to achieve specified and measurable results while performing the experiments.
CLO 7	Formulate the ability to communicate individual opinion effectively across the members of the team.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X		X							
CLO 2	X	X		X							
CLO 3	X	X	X	X							
CLO 4	X	X	X	X							
CLO 5	X	X	X	X							
CLO 6			X	X	X	X	X	X		X	
CLO 7						X	X	X	X	X	

Recommended Books:

1. Power System Analysis by John J. Grainger, William D. Stevenson, Jr
2. Principle of Power System by V.K. Mehta
3. Power System Analysis by Hadi Sadat

Course Title: Electrical Properties of Materials	Year/Semester: 3/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 327	Credits: 3.0	Contact hours:3 hours lecture per week
Pre-requisite: EEE 121 (Electrical Circuits I), EEE 123 (Electrical Circuits II)		

Rationale

Creative engineering materials are continuously being developed, selected and used in all facets of industries, from consumer products to space exploration. Purposefully designed materials provide the means for modern products and tools to be built. Materials design and behavior assessment is a function of mathematics, experimentation and a firm understanding of metallurgy and material science principles.

Course Objectives are:

- To provide the idea about classification and study of a solid material according to certain rules.
- To introduce basic quantum physics and use the ideas to create a simple understanding of how electrical conduction takes place in each crystalline solid.
- To help students learn about the origin of various properties of dielectric and insulating materials.
- To provide a basic understanding of the magnetic properties of materials, including reasoning and examples.
- To make students familiarize about modern materials those are being used in everyday science.

Course Contents:

Crystal structures: Types of crystals, lattice and basis, Bravais lattice and Miller indices.
Classical theory of electrical and thermal conduction: Scattering, mobility and resistivity, temperature dependence of metal resistivity, Mathiessen's rule, Hall effect and thermal conductivity.
Introduction to quantum mechanics: Wave nature of electrons, Schrodinger's equation, one-dimensional quantum problems- infinite quantum well, potential step and potential barrier; Heisenbergs's uncertainty principle and quantum box.
Band theory of solids: Band theory from molecular orbital, Bloch theorem, Kronig-Penny model, effective mass, density-of-states.
Carrier statistics: Maxwell-Boltzmann and Fermi-Dirac distributions, Fermi energy.

Modern theory of metals: Determination of Fermi energy and average energy of electrons, classical and quantum mechanical calculation of specific heat.
Dielectric properties of materials: Dielectric constant, polarization- electronics, ionic and orientational; internal field, Clausius-Mosotti equation, spontaneous polarization, frequency dependence of dielectric constant, dielectric loss and piezoelectricity.
Magnetic properties of materials: Magnetic moment, magnetization and relative permitivity, different types of magnetic materials, origin of ferromagnetism and magnetic domains.
Introduction to superconductivity: Zero resistance and Meissner effect, Type I and Type II superconductors and critical current density.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Identify different kinds of crystal structures and different directions and planes in the structure.
CLO 2	Understand certain modern properties of different materials like piezoelectricity, meta material property etc.
CLO 3	Describe different terms of polarization and how it happens in dielectric materials.
CLO 4	Develop the concept of quantum physics to analyze dynamics of particle like electron and photon.
CLO 5	Derive and explain some classical models of electrical and thermal conduction and use these models to calculate and explain different properties of a material.
CLO 6	Analyze the electrical, magnetic and optical properties of materials.
CLO 7	Distinguish the structure of different types of materials.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									X
CLO 5	X	X									
CLO 6	X	X									
CLO 7	X										

Recommended Books
1) Principles of Electronic Materials and Devices by Safa O. Kasap
2) Electronic Properties of Materials, by Rolf Hummel.

Course Title Digital Signal Processing I	Year/Semester: 3/1	Course Status: Theory (Compulsory, Major)
Course Code: EEE 331	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 231 (Signals and Linear Systems)		

Rationale
This course is an introduction to the exciting and rapidly advancing field of Digital Signal Processing. It is expected that upon successful completion of the course, students will have
developed the ability to understand and implement basics of Digital Signal Processing. The ability to see a system and a signal for what it is -- information in motion; gives the student a solid skill base for their future career.

Course Objectives are:
- To help the students to develop ability to carry out the operations involved in analog to digital conversion and vice versa of a signal.
- Make the students understand the different characteristics of discrete time system and signals in time and frequency domain.
- Apply knowledge of z-transform in analysis of discrete time signals and systems.
- To develop skills to perform Fourier transform in analysis of discrete time signals and systems.
- To facilitate necessary knowledge about the structure, application and design of important discrete time systems and filters.

Course Contents:
Introduction to digital signal processing (DSP): Discrete-time signals and systems, analog to digital conversion, impulse response, finite impulse response (FIR) and infinite impulse response (IIR) of discrete-time systems, difference equation, convolution, transient and steady state response.
Discrete transformations: Discrete Fourier series, discrete-time Fourier series, discrete Fourier transform (DFT) and properties, fast Fourier transform (FFT), inverse fast Fourier transform, z-transformation - properties, transfer function, poles and zeros and inverse z-transform.
Correlation: circular convolution, auto-correlation and cross correlation.
Digital Filters: FIR filters- linear phase filters, specifications, design using window, optimal and frequency sampling methods; IIR filters- specifications, design using impulse invariant, bi-linear z-transformation, least-square methods and finite precision effects.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to

CLO 1	Explain basic discrete-time signal and system types, convolution sum,

	impulse and frequency response concepts for linear, time-invariant (LTI) systems, difference equation realization of LTI systems and discrete-time
CLO 2	Describe periodic sampling of analog signals and the relation between Fourier transforms of the sampled analog signal and the resulting discrete-time signal.
CLO 3	Convert A/D and D/A signal and analyze characteristics
CLO 4	Apply transformation for solving difference equations.
CLO 5	Analyze signal and system models to understand behavior
CLO 6	Construct signal flow graph and block diagram representations of difference equations that realize digital filters: (i) Learns direct forms 1 and 2 for IIR filter realization. (ii) Learns direct form for FIR filter realization.
CLO 7	Formulate basic digital filter design methods: (i) Learns analog Butterworth and Chebyshev filters transformed to yield digital IIR filters, (ii) impulse-invariance and bilinear transformation methods for IIR filter design and (iii) FIR filter design methods based on windowing.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X									
CLO 4	X	X									
CLO 5	X										
CLO 6	X	X									X
CLO 7	X	X									X

Recommended Books

1. John G. Proakis and D. G. Manolakis: Digital Signal Processing: Principles, Algorithms, and Applications.
2. Alan V. Oppenheim, Ronald W. Schafer with John R. Buck: Discrete-Time Signal Processing.

Course Title Digital Signal Processing I Lab	Year/Semester: 3/1	Course Status: Lab (Compulsory, Major)
Course Code: EEE 332	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 231 (Signals and Linear Systems)		

Rationale

The course will be delivered in a practical manner and students will be asked to code algorithms in MATLAB to demonstrate deep and practical understanding of the course material. It is expected that upon successful completion of the course, students will have developed the ability to code and understand advanced Digital Signal Processing algorithms. The ability to code well-known
Digital Signal Processing algorithms reinforces a solid understanding of the algorithms. This course is designed to complement the theoretical course EEE 331.

Course Objectives are:

- Foster the analytical and critical skills to implement Digital Signal Processing algorithms in MATLAB.
- To develop skills for applying problem-solving skills in Digital Signal Processing through an emphasis on practical usage.
- To assist students to increase understanding of the theory through coding and implementation of Digital Signal Processing algorithms in MATLAB.

Course Contents:

1. Study of Sampling Quantization and Encoding
2. Time Domain Analysis of DT Signals and Systems
3. Z-Transform and Analysis
4. Frequency Domain Analysis of DT Signal and Systems
5. Digital Filter Design

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explore several time domain operations and analysis of discrete time signals.
CLO 2	Implement sampling, quantization and encoding
CLO 3	Compare several time domain behaviors of discrete time signals in Z-domain.
CLO 4	Analyze fundamental concepts of DTFT, DTFS and DFT and Explore the problem of aliasing
CLO 5	Develop the quality of teamwork and effective communication skills.
CLO 6	Design digital filters from specification through coefficient calculation and apply the knowledge in practical applications.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X		X	X						
CLO 2	X	X		X							
CLO 3	X	X		X							
CLO 4	X	X		X							
CLO 5						X	X	X	X	X	
CLO 6	X	X		X	X						X

Recommended Books

1. John G. Proakis and D. G. Manolakis: Digital Signal Processing: Principles, Algorithms, and Applications.
2. Alan V. Oppenheim, Ronald W. Schafer with John R. Buck: Discrete-Time Signal Processing

Course Title: Fundamentals of Mechanical Engineering	Year/Semester: 3/1	Course Status: Theory (Compulsory, Non-major)
Course Code: MEE 313E	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: None		

Rationale
This course is a fundamental course on mechanical structure and designing which is designed to provide the basic concepts of mechanical tools and equipment to electrical engineering students.

Course Objectives are
The objectives of this course are:
- To understand the various forms of conventional energy resources
- To introduce students to the Thermodynamics
- To learn about Thermodynamics Laws.
- To learn about different Fluid Machineries
- To understand the working principle of different Thermal Engines

Course Contents:
Sources of Energy: Classification, Applications, Advantages and Disadvantages; Thermodynamics: Basic concepts and definitions of cycle, Properties, Process, 1st and 2nd laws of Thermodynamics and their application; Thermal Engines: IC Engine, Gas Turbine, Boiler, Steam Turbine: Classification, Operating Principle, Performance, and Applications; Fluid
Machineries: Turbine, Pump, Compressor, Blower, Fan: Classification, Operating Principle, Performance, Applications.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Describe the environmental aspects of non-conventional energy resources
CLO 2	Differentiate among various conventional energy systems, their prospects and limitations
CLO 3	Know the need of renewable energy resources, historical and latest developments
CLO 4	Understand the law's of Thermodynamics
CLO 5	Calculate brake power and mechanical efficiency of IC engines
CLO 6	Understand working principle of gas turbine and steam turbine and their advantages and disadvantages
CLO 7	Calculate COP of Refrigeration system
CLO 8	Differentiate Turbine, Pump, Compressor, Blower and Fan
CLO 9	Learn Boiler mountings and accessories

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X									
CLO 4	X	X									
CLO 5	X				X				X		
CLO 6	X										
CLO 7	X										
CLO 8	X										
CLO 9	X										

Recommended Books
1. Devendra Vashist - Mechanical Engineering: Fundamentals
2. R.L. Timings - Fundamentals of Mechanical Engineering
3. Claus Borgnakke, Richard E. Sonntag - Fundamentals of Thermodynamics
4. Munson - Fundamentals of Fluid Mechanics

Course Title: Basic Communication Engineering	Year/Semester: 3/2	Course Status: Theory (Compulsory, Major)
Course Code: EEE 329	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: MAT 201E (Ordinary and Partial Differential Equations), EEE229 (Electromagnetic Fields and Waves) and EEE 323 (Digital Electronics)		

Rationale:
A graduate of Electrical and Electronic Engineering is expected to acquire profound knowledge about basic communication techniques. The course also introduces analytical techniques to evaluate the performance of communication systems.
Course objectives are:
- To help students develop a solid background on the fundamental concepts of analog & digital communication technologies.
- To introduce the field of Electronic Communications.
- Getting idea about other communication courses in the upcoming semesters and postgraduate studies.
- To facilitate necessary knowledge about pursuing research in communications
- Foster the analytical and critical ability of students to work in communication Sectors

Course Contents:
Overview of communication systems: Basic principles, fundamental elements, system limitations, message source, bandwidth requirements, transmission media types, and bandwidth and transmission capacity.
Noise: Source, characteristics of various types of noise and signal to noise ratio.
Information theory: Measure of information, source encoding, error free communication over a noisy channel, channel capacity of a continuous system and channel capacity of a discrete memory less system.
Communication systems: Analog and digital.
Continuous wave modulation: Transmission types – base-band transmission, carrier transmission; amplitude modulation – introduction, double side band, single side band, vestigial side band, quadrature; spectral analysis of each type, envelope and synchronous detection; angle modulation –instantaneous frequency, frequency modulation (FM) and phase modulation (PM), spectral analysis, demodulation of FM and PM.
Pulse modulation: Sampling – sampling theorem, Nyquist criterion, aliasing, instantaneous and natural sampling; pulse amplitude modulation - principle, bandwidth requirements; pulse code modulation (PCM) - quantization principle,

quantization noise, non-uniform quantization, signal to quantization error ratio, differential PCM, demodulation of PCM; delta modulation (DM) - principle, adaptive DM; line coding – formats and bandwidths. Digital modulation: Amplitude-shift keying - principle, ON-OFF keying, bandwidth requirements, detection, noise performance; phase-shift keying (PSK) - principle, bandwidth requirements, detection, differential PSK,
quadrature PSK, noise performance; frequency-shift Keying (FSK) - principle, continuous and discontinuous phase FSK, minimum-shift keying, bandwidth requirements, detection of FSK.
Multiplexing: Time- division multiplexing (TDM) - principle, receiver synchronization, frame synchronization, TDM of multiple bit rate systems; frequency-division multiplexing - principle, de-multiplexing; wavelength-division multiplexing, multiple-access network – time-division multiple-access, frequency-division multiple access; code-division multiple- access (CDMA) - spread spectrum multiplexing, coding techniques and constraints of CDMA. Communication system design: design parameters, channel selection criteria and performance simulation

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Explain analogue and digital communication basics.
CLO 2	Understand how sampling and quantization is done.
CLO 3	Describe time division and frequency division multiplexing processes.
CLO 4	Calculate different communication medium parameters
CLO 5	Distinguish different continuous wave modulation techniques.
CLO 6	Formulate an efficient form of digital communication.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5	X	X									
CLO 6	X	X									X

Recommended Books:
1. Modern Analog & Digital Communication System-B.P.Lathi&Z.Ding.
2. Communication System by Simon Haykin&M.Moher.

Course Title: Basic Communication Engineering Lab	Year/Semester: 3/2	Course Status: Lab (Compulsory, Major)
Course Code:EEE 330	Credits: 1.5	Contact hours:3 hours lab per week
Pre-requisite: MAT 201E (Ordinary and Partial Differential Equations), EEE 229 (Electromagnetic Fields and Waves) and EEE 323 (Digital Electronics)		

Rationale

This course provides a thorough introduction to the basic principles and techniques used in analog and digital communications. A graduate of Electrical and Electronic Engineering is expected to acquire profound knowledge about these basic communication techniques. The theoretical knowledge is incomplete without hands on experiments using the basic components and training modules showing modulation and demodulation techniques. This course is designed to complement the theoretical course EEE 330.

Course Objectives are
- To develop skills to simulate modulation techniques of analog communication systems.
- To help explore and understand demodulation techniques of analog communication systems
- To enhance the skills to simulate modulation techniques of digital communication systems.
- Acquaint students with experiments of demodulation techniques of digital communication systems
- To enable the students to establish the connection and understand differences between analog and digital representation and transmission of information.

Course Contents:
1. AM modulation and demodulation technique.
2. FM modulation and demodulation technique.
3. PM modulation and demodulation technique.
4. DM modulation and demodulation technique.
5. PWM and PCM modulation and demodulation technique.
6. Line coding and decoding
7. ASK modulation and demodulation technique.
8. FSK modulation and demodulation technique.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Understand AM, FM, PM and DM modulation and demodulation technique
CLO 2	Explore PWM and PCM modulation and demodulation technique
CLO 3	Implement FSK modulation and demodulation technique
CLO 4	Demonstrate Different kind of line coding techniques and demodulation of those line coding
CLO 5	Conduct experiment on ASK modulation and demodulation technique
CLO 6	Evaluate the quality of teamwork and effective communication skills.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X	X	X							
CLO 2	X	X	X	X							
CLO 3	X	X	X	X							
CLO 4	X	X	X	X							X

CLO 5	X	X	X	X							
CLO 6						X	X	X	X	X	

Recommended Books

1. Communication Systems by Simon S. Haykin
2. Communication Theory: Epistemological Foundations by James Arthur Anderson
3. Modern Digital and Analog Communication System by B.P. Lathi

Course Title: Microprocessor and Interfacing		Year/Semester: 3/2	Course Status: Theory (Major, compulsory)
Course Code: EEE333	Credit: 3.0	Contact hours: 3 hours Lecture per week	
Pre-requisite: EEE 323 (Digital Electronics)			

Rationale:

We live in the new era of "Smart Machines." Think about self-driving cars, phones, washing machines or any device with built-in intelligence - what governs this intelligence? Microprocessors! Today, the use of a processor is limited only by the engineer's imagination. The purpose of this course is to teach students the fundamentals of microprocessor and microcontroller systems. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via a microprocessor/controller implementation.

Course objectives are:

- To help students to understand the main components and working principals of the Intel 80x86 microprocessor.
- To develop skills to program and debug in assembly language.
- To provide basic knowledge to understand the memory organization and memory interfacing.
- To develop skills to interface a microprocessor to external input/output devices and perform input/output device programming in assembly.
- Help students conceptualize the hardware and software interrupts and their applications.
- Make the students to understand the properties and interfacing of the parallel and serial port.
- Apply the knowledge to design and program software for programmable peripheral devices.
- To familiarize students with the future trends in microprocessors and microcontrollers.

Course Contents:

Introduction to microprocessors, microprocessor evolution and type, introduction to Intel microprocessor family, Intel 8086 microprocessor: Architecture, bus timing, addressing modes, instruction sets, assembly language programming. Memory organization, interrupts, interrupt types, interrupt vector table. Interfacing: programmable peripheral interface, programmable timer, serial communication interface, programmable interrupt controller, direct memory access controller, keyboard and display interface. Serial and parallel communication types, serial I/O communication (Synchronous & Asynchronous) Introduction to micro-controllers.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Understand the internal workings of an Intel 8086 microprocessor.
CLO 2	Describe microcontroller working principles.
CLO 3	Explain how serial and parallel communication work.
CLO 4	Discuss how a computer system is interfaced with peripheral input/output devices.
CLO 5	Interpret how computer systems are designed.
CLO 6	Demonstrate how memory is organized in systems and synchronized with systems.
CLO 7	Apply assembly language to write different programs.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5	X										
CLO 6	X										
CLO7	X	X									X

Recommended Books:

1. Microprocessors and Interfacing: Programming and Hardware by Douglas V. Hall.
2. Microprocessors, PC hardware and Interfacing by N. Mathivanan.
3. Assembly Language Programming and Organization of the IBM PC by Ytha Yu and Charles Marut.

Course Title: Microprocessor and Interfacing Lab	Year/Semester: 3/2	Course Status: Lab (Major, compulsory)
Course Code: EEE 334	Credit: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 324 (Digital Electronics Lab)		

Rationale:

We live in the new era of "Smart Machines." Think about self-driving cars, phones, washing machines or any device with built-in intelligence - what governs this intelligence? Microprocessors! Today, the use of a processor is limited only by the engineer's imagination. The purpose of this course is to teach students the fundamentals of microprocessor and microcontroller systems. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via a microprocessor/controller implementation. The theoretical knowledge is incomplete without hands on experiments using the 8086

module and microprocessor/microcontroller based project work. This course is designed to complement the theoretical course EEE 333.

Course objectives are:

- To help students to understand the main components and working principals of the Intel 80x86 microprocessor.
- To develop skills to program and debug in assembly language.
- To provide basic knowledge to understand the memory organization and memory interfacing.
- To help students debug and understand how every instruction in 8086 works.
- To provide basic knowledge to interface 8086 kits with computer and program using more advance assembler.

Course Contents:

1. Familiarization with MDA-8086 microprocessor kit and its operation in "Machine Code" mode using arithmetic instructions.
2. Logic operation in 'Machine Code' mode and verification.
3. Control operation in 'Machine Code' mode and verification.
4. Study on the programming of 8255 PIO controller by utilizing the 7-segment display and the LEDs in the MDA-8086 module.
5. Study on the programming of 8255 PIO controller by utilizing the 8x8 LED ARRAY or DOT MATRIX ARRAY.
6. Study on interface between PC and MDA-8086 using serial monitor and performing advance assembly programming using PC.
7. Design microprocessor-based systems.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Identify different assembly language instructions.
CLO 2	Understand 8086 microprocessor's working principle.
CLO 3	Interpret different registers and pointer values.
CLO 4	Demonstrate the instructions executed and their affect on Flag register.
CLO 5	Program different output devices.
CLO 6	Design small microprocessor systems.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X	X	X								
CLO 3	X	X	X	X							
CLO 4	X	X	X	X							
CLO 5	X	X	X	X							X
CLO 6	X	X	X	X	X						X

Recommended Books:

1. Microprocessors and Interfacing: Programming and Hardware by Douglas V. Hall.
2. Microprocessors, PC hardware and Interfacing by N. Mathivanan.
3. Assembly Language Programming and Organization of the IBM PC by Ytha Yu and Charles Marut.

Course Title: Control System I	Year/Semester: 3/2	Course Status: Theory (Major, compulsory)
Course Code: EEE 335	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 231 (Signals and Linear systems)		

Rationale

"Control System Engineering" is concerned with modelling and manipulating physical systems so that they behave in a desired way. Desired behaviors are articulated by specification. This course will introduce the students to the formalisms, tools, and methodologies that form the foundations control systems engineering. At the completion of this course they will have developed an understanding of the scope and application of control systems engineering, they will have enhanced their modelling and analysis skills, and they will have developed skills in
control system design. Students from previous years often comment that the broad nature of this course expands their intellectual horizons.

Course Objectives are:

- To assist students in building systems models of mechanical, electrical, and electromechanical systems.
- To facilitate necessary knowledge to analyze the transient and steady state performance of these systems.
- To provide basic knowledge to use the principle of feedback to alter this performance to achieve a desired behavior specification.

Course Contents:

Introduction: Introduction to control systems, Modeling in time domain
Linear system models: transfer function, block diagram and signal flow graph (SFG).
State variables: SFG to state variables, transfer function to state variable and state variable to transfer function, Modeling in frequency domain.
Feedback control system: Closed loop systems, parameter sensitivity, transient characteristics of control systems, effect of additional pole and zero on the system response and system types, stability and steady state error. Routh stability criterion.
Analysis of feedback control system: Root locus method and frequency response method, Design via root locus, design via frequency response, Nyquist criterion, Bode plot, PLC based control system.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand system models
CLO 2	Apply frequency response design technique and interpreting bode plot.
CLO 3	Illustrate the root locus of transfer functions to design practical systems.
CLO 4	Analyze system models to understand their behavior
CLO 5	Design and Implement Feedback Control Loops

CLO 6	Formulate a control system with required specification

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									X
CLO 4	X	X									
CLO 5	X	X									
CLO 6	X	X			X						X

Recommended Books

1. Control Systems Engineering by Norman S. Nise
2. Modern Control Engineering by Katsuhiko Ogata
3. Modern Control Systems by Richard C. Dorf

Course Title: Control System I Lab	Year/Semester: 3/2	Course Status: Lab (Major, compulsory)
Course Code: EEE 336	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 231 (Signals and Linear Systems)		

Rationale

EEE students need to have a broad idea in modelling and manipulating physical systems so that they behave in a desired way. At the completion of this course the students will have
developed an understanding of the scope and application of control systems engineering, they will have enhanced their modelling and analysis skills, and they will have developed skills in control system design. The theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in Control engineering. This course is designed to complement the theoretical course EEE 335.

Course Objectives are

- To assist students in building systems models of mechanical, electrical, and electromechanical systems.
- To facilitate necessary knowledge to analyze the transient and steady state performance of these systems.
- To provide basic knowledge to use the principle of feedback to alter this performance to achieve a desired behavior specification.

Course Contents:

1. Generating State Space Representation from a Transfer Function and vice versa via Simulation
2. Time Performance Analysis of Systems by evaluating the Effect of Pole Location upon the Time Response of 1st & 2nd -order systems.
3. Implementation of Block Diagram Reduction
4. Stability Analysis
5. Analysis of Steady-State Performance for Step and Ramp Inputs.
6. Designing the Gain of a Controller via Root Locus.
7. Designing a PID Controller

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the equivalency of the basic forms and basic moves and the effect of pole location upon stability
CLO 2	Explore the root locus technique as a tool for estimating the effect of open-loop gain upon the transient response of closed-loop systems.
CLO 3	Design a PID controller using MATLAB's SISO Design Tool to observe the effect of a PI and a PD controller on the magnitude and phase responses at each step of the design of a PID controller
CLO 4	Estimate symbolic transfer functions from the state-space representation and state space representations from the equations of motion.
CLO 5	Evaluate the effect of pole and zero location upon the time response of first- and second-order systems
CLO 6	Devise the quality of teamwork and effective communication skills.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X		X							
CLO 2	X	X		X	X						
CLO 3	X	X	X	X	X						
CLO 4	X	X		X							
CLO 5	X	X		X							
CLO 6						X	X	X	X	X	

Recommended Books

1. Control Systems Engineering by Norman S. Nise
2. Modern Control Engineering by Katsuhiko Ogata
3. Modern Control Systems by Richard C. Dorf

Course Title: Power System II	Year/Semester: 3/2	Course Status: Theory (Major, compulsory)
Course Code: EEE 337	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 325 (Power System I)		

Rationale:

Modern power systems have grown larger with many interconnections between neighboring power systems. Proper planning, operation and control of such large power systems require advanced computer-based techniques. This course will provide a strong foundation in classical methods and modern techniques in power systems for senior level electrical engineering students. Course content includes the concepts of Series Impedance of Transmission Lines, Capacitance of Transmission Lines, Underground Cables, Mechanical Design of Overhead Line, Stability,Compensation in Power System and High Voltage DC Transmission System.

Pre-requisite: EEE 325(Power System I)

Course Objectives are

- To provide students with a good understanding to formulate and solve the mathematical models describing steady-state physical behavior of transmission and distribution lines.
- To assist students to understand and describe operational concepts such as: flow of active & reactive power, voltage profile, steady-state stability, power flow limits & line load ability, voltage regulation, Surge Impedance Loading.
- To facilitate necessary knowledge to analyze line compensation techniques as applied in reactive power – voltage control and active power flow control.
- To make students familiarize with the stability problem in power systems, rotor dynamics and swing equation.
- To provide the basic concepts related to the power quality of transmission system.

Course Contents:

Series Impedance of Transmission Lines: Resistance, Inductance, Inductance of a Conductor due to Internal Flux, Flux Linkage Between two points external to an isolated conductor, Inductance of a single-phase two-wire line, Flux linkages of one conductor in a group,

Inductance of Composite-Conductor lines, Inductance of three-phase lines with equilateral spacing, Inductance of three-phase lines with unsymmetrical spacing, Bundled Conductors.

Capacitance of Transmission Lines: Electric field of a long straight conductor, The potential difference between two points due to a charge,Capacitance of a two-wire line, Capacitance of a three-phase line with equilateral spacing, Capacitance of a three-phase line with unsymmetrical spacing, Effect of earth on the capacitance of three-phase transmission line, Bundled Conductors.

Underground Cables: Construction of cables, Insulating material of cables, Classification of cables, Cables for three-phase service, Laying of cables, Insulating resistance of a single-core cable, Capacitance of a single core cable, Dielectric stress of single core cable, Grading of cable, Capacitance grading, Inter-sheath grading, Capacitance of 3-core cable,

Measurement of C_e and C_c, Current carrying capacity of cable, Thermal resistance, Permissible current loading, Types of cable fault.

Mechanical Design of Overhead Line: Main components of overhead line, Conductor Material, Line Support, Insulators, Types of Insulator, Potential Distribution over Suspension insulator String, String efficiency, Method of improving string efficiency, Corona, Sag in overhead Line, Calculation of Sag,

Stability: Swing equation, Synchronous machine models for stability studies, Steady –State Stability, Transient- Stability- Equal area criterion, Application to sudden increase in power input, Application to three-phase fault, Numerical solution of Swing equation, Multi machine system, Multi machine transient stability, Factors affecting stability.

Compensation in Power System: load compensation, line compensation, series compensation, shunt compensators, flexible ac transmission systems (facts), facts controllers.

Flexible AC Transmission Systems (FACTs):FACTs devices and Application.

High Voltage DC Transmission System: Comparison of DC and AC system, Application of DC Transmission System, Types ofHVDC system, HVDC system configuration and components, Control of HVDC system, Response to DC and AC system faults.

Power Quality: Electromagnetic phenomena and powerquality; temporary phenomena (transient, long duration voltage variations, sustained interruptions, short duration voltage variations), Interruption, Voltage sags and swells, harmonics. steady state phenomena; voltage imbalance, waveform distortion, voltage fluctuation and flicker, power frequency variations.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain in detail and critically evaluate technologies and information systems for operational management of conventional and modern electric power systems.
CLO 2	Recognize the need to continuously follow the advancements in technology and incorporating them in the present system to improve efficiency.
CLO 3	Choose the appropriate type of power generating station following norms and guidelines related to cost, environment, societal and ethical issues. Also review the different tariff systems available and determine the one most appropriate for a given scenario to optimize the revenue earned.
CLO 4	Analyze the stability of a power transmission system by measuring appropriate parameters.
CLO 5	Implement the knowledge of basic mathematical, physical and electrical principles to formulate significant electrical hazards.
CLO 6	Evaluate the suitability of installing overhead and underground power transmission strategies considering electrical, mechanical, environmental, performance, safety and economic constraints.
CLO 7	Formulate the mathematical models Using the effect of inductance and capacitance for interconnected electrical power networks.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
LO 2	X	X									X
CLO 3	X	X			X					X	X
CLO 4	X	X									
CLO 5	X	X									
CLO 6	X	X			X						X
CLO 7	X	X									

Recommended Books

1. Power System Analysis by John J. Grainger, William D. Stevenson, Jr
2. Principle of Power System by V.K. Mehta
3. Power System Analysis by Hadi Sadat

Course Title: Power Electronics	Year/Semester: 3/2	Course Status: Theory (Major, compulsory)
Course Code: EEE 339	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 221 (Electronics I), EEE 227 (Electronics II), EEE 325 (Power		

System I) and their labs

Rationale:
Power electronic circuits nowadays are essential for a whole array of consumer and industrial electronic products. At low power end they include switched mode regulated power supply of hand held devices, TV, light fittings, computers and other entertainment systems. At high power end, there are diverse industrial applications in power electronic converters for variable speed drives, in automotive and railway traction, in textile, paper, steel rolling mills, ship propulsion and positioning, aircraft actuators and navigation; High voltage DC transmission, grid connection for PV systems and wind generators and power supply for telecommunication equipment to name a few.

Course objectives are:
- To help students to understand basic components of power electronics and learn their key characteristics,
- To facilitate necessary knowledge to analyze, model and predict performance of basic power converters systems,
- To develop skills on power electronic topologies,
- To develop a good insight of operational issues and limitations of power converters,
- To assist students to design proper switching circuits to achieve a desired behavior specification.

Course Contents:
Power semiconductor switches and triggering devices: BJT, MOSFET, SCR, IGBT, GTO, TRIAC, UJT and DIAC. Rectifiers: Uncontrolled and controlled single phase and three phase. Regulated power supplies: Linear-series and shunt, switching buck, buck boost, boost and Cuk
regulators. AC voltage controllers: single and three phase. Choppers, DC motor control. Single phase cyclo-converter. Inverters: Single phase and three phase voltage and current source. AC motor control. Stepper motor control. Resonance inverters. Pulse width modulation control of static converters, Controlled and Uncontrolled Rectifiers.

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Understand AC and DC machines control systems circuits.
CLO 2	Identify the basic components of power electronics like BJT, MOSFET, SCR, IGBT, GTO, TRIAC, UJT and DIAC.
CLO 3	Explain inverters working principle and design procedure.
CLO 4	Design regulated power supplies.
CLO 5	Develop uncontrolled and controlled single phase and three phase rectifiers
CLO 6	Describe differences and design of AC and DC power systems.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									
CLO 4	X	X			X						
CLO 5	X	X									
CLO 6	X										

Recommended Books:
1. Power Electronics, Circuits, Devices, and Applications by Muhammad H. Rashid
2. Introduction to Power Electronics by D. W. Hart
3. Power electronics systems: theory and design by Agrawal, Jai P.
4. Modern Power Electronics and AC Drives by Bimal K. Bose

Course Title: Power Electronics Lab	Year/Semester: 3/2	Course Status: Lab (Major, compulsory)
Course Code: EEE 340	Credit: 1.5	Contact hours: 3 hours of lab per week
Pre-requisite: EEE 221 (Electronics I), EEE 227 (Electronics II), EEE 325 (Power System I) and corresponding labs		

Rationale:
EEE students need to have a broad idea in modeling and manipulating wide range of power converters for different power conversion. At the completion of this course the students will have developed an understanding of the scope and application power electronics, they will have enhanced their modeling and analysis skills, and they will have developed skills in converter design. The theoretical knowledge is incomplete without hands on experiments using the basic
components and measuring devices used in power electronics. This course is designed to complement the theoretical course EEE 340.

Course objectives are:
- To help students to understand basic components of power electronics and learn their key characteristics,
- To facilitate necessary knowledge to analyze, model and predict performance of basic power converters systems,
- To develop skills on power electronic topologies,
- To develop a good insight of operational issues and limitations of power converters,
- To assist students to design proper switching circuits to achieve a desired behavior specification.

Course Contents:
1. Study of Switching Characteristic of BJT, MOSFET, SCR, IGBT and TRIAC.
2. Design of basic pulse width generator using BJT, MOSFET and SCR.
2. Switch Mode Power Supply: Buck, Boost & Buck-Boost Converter.
3. Basic Single Phase Cyclo-converter Circuit.
4. Basic Single-Phase Inverter Circuits: Push Pull and Half/Full Bridge Inverter.

5. Controlled single phase and three phase Rectifier using SCRs.
6. Operation of a three phase Inverter.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Identify the basic components of power electronics.
CLO 2	Understand Buck and Boost converters inner workings.
CLO 3	Describe basic components characteristics and working parameters.
CLO 4	Explain inverters working principle and design procedure.
CLO 5	Design pulse width generators using different components.
CLO 6	Develop single phase and three phase rectifiers.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X	X								
CLO 2	X	X	X								
CLO 3	X	X	X	X							
CLO 4	X	X	X	X							
CLO 5	X	X	X	X							
CLO 6	X	X	X	X	X						

Recommended Books:

1. Power Electronics, Circuits, Devices, and Applications by Muhammad H. Rashid
2. Introduction to Power Electronics by D. W. Hart
3. Power electronics systems: theory and design by Agrawal, Jai P.
4. Modern Power Electronics and AC Drives by Bimal K. Bose

Fourth Year

Course Title: Project/Thesis (Initial Work)	Year/Semester: 4/1	Course Status: Lab (Major, Compulsory)
Course Code: EEE 400	Credits: 2.0	Contact hours: 4 hours lecture per week
Pre-requisite: None		

Rationale:

This course is a part of B.Sc. (Engg.) program in Electrical and Electronic Engineering.

Course Objectives are

- To understand the basics of doing scientific research
- Be conversant on analysis of scientific data.
- To provide knowledge about how to present scientific work.
- To develop skills to do research along with understanding of the current research questions.
- To make students familiarethical issues in an adequate manner related to the scientific work.

Course Contents:

The undergraduate thesis /project within the field of Electrical and Electronic Engineering research is an individual study that must include hypothesis testing that will substantiate new data.

The undergraduate thesis/project includes search, studies and summary of scientific literature, practical work in close relation to ongoing Electrical and Electronic Engineering research, compilation and critical analysis of the results, and oral and written presentation.

The undergraduate thesis/project is mastered under individual supervision. The supervision includes how to perform a scientific study and how to orally and in writing present gathered data in good scientific manner. The supervisor must have documented scientific experience.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain basic knowledge on how to pursue scientific fact.
CLO 2	Explain basics of planning and performance of a scientific work.
CLO 3	Explain basics of analysis of scientific data.
CLO 4	Illustrate basic knowledge on how to present scientific work.
CLO 5	Obtain Theoretical and practical professional specialization within Electrical and Electronic Engineering including understanding of the current research questions.
CLO 6	Search scientific literature.
CLO 7	Summarize scientific literature.
CLO 8	Discuss scientific data related to the question at hand.
CLO 9	Present scientific data and conclusions in written and oral form addressed to different groups.
CLO 10	Understand and analyze ethical issues in an adequate manner related to the scientific work.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5			X	X	X	X	X	X	X		X
CLO 6	X	X									
CLO 7		X			X						
CLO 8	X	X				X					
CLO 9						X			X		
CLO 10										X	

Course Title:Industrial Training	Year/Semester: 4/1	Course status: Compulsory,Major

Course Code: EEE 402	Credits: 1.0	Contact hours: As required

Rationale

This is an introductory course in Electrical and Electronic Engineering, introducing simple electrical DC circuits as well as the technical skills to analyze such simple and complex circuits.

It is a course suitable for students pursuing further studies in electrical, electronic or telecommunications engineering as well as some other related engineering disciplines including computer engineering. It gives the through idea about different types of circuit analysis techniques. In the practical section, it provides hands-on experience in building and testing circuits. It is packaged in such a way that students, having taken this course, can go away and build and analyze some practical, useful devices afterwards. It is a pre-requisite for the subsequent course on Circuits and Signals.

Course Objectives are-

- To facilitate necessary knowledge about electrical safety & protective devices
- Acquaint students with the basic tools of electrical testing & measuring instrument
- Help them conceptualize basic theories in Transformer, Generators & Motors
- Make the students understand the electrical power plant along with substation & distribution system
- To facilitate necessary knowledge about power factor improvement plant
- To provide the knowledge of motor control by AC drive
- To understand basic process instrumentation symbol & drawings
- Accumulate basic ideas about controller, control loop & Control Valve
- To enhancing the skill on Sequential Logic Operation, Programmable Logic Controller (PLC) and Distributed Control System (DCS)
- Acquaint students with the basics of bearings and turbines
- Foster the analytical and critical machine Alignment
- To provide the knowledge of boiler & Steam system

Course Content-

Electrical Safety; Electrical switching & protective devices, symbols; Conductors, cables, insulators; Electrical testing & measuring instrument; Transformer; Generators & motors; Starting and control of induction motors; Electrical power plant; Substation & distribution system; Earthing system & Measurement of Earth Resistance; Power factor improvement plant; Parallel operation of generators with Synchronization and load sharing of Generator; Power plant starting procedure, control room activities, inspection and troubleshooting; Generator protection system; Motor control by AC drive; Introduction to process instrumentation; Instrumentation symbol & drawings; Transmitter; Controller & control loop; Control Valve; Sequential Logic Operation; Programmable Logic Controller (PLC); Distributed Control System (DCS); Vibration Analysis Technology; Bearings; Turbines; Introduction to Machine Alignment; Boiler & Steam system

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Identify the electrical protective devices
CLO 2	Explain working procedure of a power plant and its components
CLO 3	Operate the electrical testing & measuring instrument
CLO 4	Operate PLC and DCS
CLO 5	Calculate the power factor of a system and also able to improve
CLO 6	Apply the basics of AC drive to control a motor
CLO 7	Distinguish between generator and motor and also able to operate
CLO 8	Design a control loop
CLO 9	Evaluate the usefulness of boiler in a power plant

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X	X									
CLO 3			X	X							
CLO 4			X	X							
CLO 5				X	X						
CLO 6				X	X						
CLO 7	X	X	X	X							
CLO 8				X	X	X	X	X	X		
CLO 9	X								X		X

Recommended Books

1. Fundamental of Electric Circuits by Charles K. Alexander, Mathew N.O. Sadiku R.
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Prinicple of Electric Machines by V. K. Mehta
4. Prinicple of Power Systems by V. K. Mehta

Course Title: Solid State Devices	Year/Semester: 4/1	Course Status: Theory (Major, optional)
Course Code:EEE 421	Credits: 3.0	Contact hours: 3 hours Lecture per Week
Pre-requisite: EEE 221 (Electronics I)		

Rationale:

This course is the next stage of learning about electronic devices and electrical materials that had been taught previously in Electronics I and Electrical Properties of Materials i.e. using the said material properties in our favor by creating the said electronic devices. The lectures start from basic ideas about material properties and goes onto using them in the electronic devices that we use daily, i.e. Diodes, transistors. These are the devices that we use today on regular basis and learning about their internal mechanism from a microscopic point of view should be quiet fun! This course is the steppingstone on pursuing higher learning in fields of device and material synthesis and will act as prerequisite for courses like Compound Semiconductor and Hetero-junction Devices, Optoelectronics, and Semiconductor Device Theory.

Course Objectives are

- To provide the basic concepts of semiconductor fundamentals and drift diffusion model for charge carriers in semiconductors,
- To provide the knowledge for the analysis of basic functions of nonlinear devices like p-n junctions, BJTs, MOSFETs and JFETs.
- To develop ability To facilitate necessary knowledge to analyze the basic device parameters, associated with device geometry, doping profile and applied voltages for SPICE simulation.
- To help in developing the skills to apply the knowledge of device parameters to improve device/circuit performance.

Course Contents:

Semiconductors in equilibrium: Energy bands, intrinsic and extrinsic semiconductors, Fermi levels, electron and hole concentrations, temperature dependence of carrier concentrations and invariance of Fermi level.

Carrier transport processes and excess carriers: Drift and diffusion, generation and recombination of excess carriers, built-in-field, Einstein relations, continuity and diffusion equations for holes and electrons and quasi-Fermi level.

PN junction: Basic structure, equilibrium conditions, contact potential, equilibrium Fermi level, space charge, non-equilibrium condition, forward and reverse bias, carrier injection, minority and majority carrier currents, transient and AC conditions, time variation of stored charge, reverse recovery transient and capacitance.

Bipolar Junction Transistor: Basic principle of pnp and npn transistors, emitter efficiency, base transport factor and current gain, diffusion equation in the base, terminal currents, coupled-diode model and charge control analysis, Ebers-Moll equations and circuit synthesis.

Metal-semiconductor junction: Energy band diagram of metal semiconductor junctions, rectifying and ohmic contacts.

MOS structure: MOS capacitor, energy band diagrams and flat band voltage, threshold voltage and control of threshold voltage, static C-V characteristics, qualitative theory of MOSFET operation, body effect and current-voltage relationship of a MOSFET.

Junction Field-Effect-Transistor: Introduction, qualitative theory of operation, pinch-off voltage and current-voltage relationship.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic physics of semiconductor electronic devices. The importance of electrons and holes in semiconductors, the charge density and distribution, the charge transport mechanisms.
CLO 2	Describe the internal workings of the most basic solid-state electronic devices.
CLO 3	Explain the physics of a p-n junction and semiconductor-metal junctions.
CLO 4	Apply device models To facilitate necessary knowledge to analyze basic functions of p-n junction and other diode devices and calculate, analyze and modify device parameters by changing device physical characteristics to change device/circuit performance.
CLO 5	Apply device models To facilitate necessary knowledge to analyze basic functions of BJT, MOS and JFET devices and calculate, analyze and modify device parameters by changing device physical characteristics to change device/circuit performance.
CLO 6	Pursue an engineering approach to develop devices that are sustainable and economically feasible.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X	X									
CLO 3	X	X									
CLO 4				X	X						
CLO 5				X	X						
CLO 6											X

Recommended Books

1. Semiconductor Physics and Devices Basic Principles by Donald A. Neamen
2. Solid State Electronics Devices (6th Edition) by Ben Streetman and Sanjay Banerjee

Course Title: VLSI Design and Testing	Year/Semester: 4/1	Course Status: Theory (Major, optional)
Course Code: EEE 455	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 323 (Digital Electronics), EEE 324 (Digital Electronics Lab)		

Rationale

CMOS is important to learn as it is a basic integrated circuit technology due to its low power (at moderate frequencies), good scalability, and rail-to-rail operation. In this course, the student is systematically introduced to the entire range of CMOS circuit design, starting with individual CMOS, basic circuit building blocks, and broad view of both combinational and sequential circuits.

Course Objectives are

- To facilitate necessary knowledgeabout the basic concepts of physics and modeling of MOSFETs.
- Acquaint students with the basic knowledge about the relationship between the processing parameters and device operation.
- To provide the knowledge of static inverter and static logic circuit design.
- Help students conceptualize the basic concepts related to the procedures for constructing random combinational logic circuits.

Course Contents:

VLSI technology: Top down design approach, technology trends and design styles.

Review of MOS transistor theory: Threshold voltage, body effect, I-V equations and characteristics, latch-up problems, NMOS inverter, CMOS inverter, pass-transistor and transmission gates.

CMOS circuit characteristics and performance estimation: Resistance, capacitance, rise and fall times, delay, gate transistor sizing and power consumption.

CMOS circuit and logic design: Layout design rules and physical design of simple logic gates.
CMOS subsystem design: Adders, multiplier and memory system, arithmetic logic unit. Programmable logic arrays. I/O systems. VLSI testing.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Identify the basic challenges in CMOS technology
CLO 2	Explain the basic MOS technology.
CLO 3	Apply the representation of an electrical network
CLO 4	Interpret the layout design and their application in industry.
CLO 5	Describe the basic challenges in system design & testing

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3		X									
CLO 4		X		X				X	X		
CLO 5				X	X				X		

Recommended Books

01. Douglas A. Pucknell, "Basic VLSI Systems and Circuits", Prentice Hall of India, 3rd Edition, reprint 2008.
02. John P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, Reprint 2009.
03. Samir Palnitkar, "Verilog HDL – Guide to Digital Design and Synthesis", Pearson Education, 3rd Edition, 2003.
04. Smith M.J.S, "Application Specific Integrated Circuits", Addison -Wesley Longman Inc., 1997.
05. Weste & Eshraghian, "Principles of CMOS VLSI Design", Addison Wesley, 2nd Edition, 2008.
06. John P Uyemura, "Chip Design for Submicron VLSI: CMOS layout and simulation", Thomson India Edition, 2010

Course Title: VLSI Design and Testing Lab	Year/Semester: 4/1	Course Status: Lab (Major, optional)
Course Code: EEE 456	Credits: 1.5	Contact hours: 3 hours lab per week
Pre-requisite: EEE 323 (Digital Electronics) and EEE 324 (Digital Electronics Lab)		

Rationale
This course introduces the design and implementation of VLSI circuits for complex digital systems using Verilog HDL. An idea about synthesis and timing analysis of a design can be performed using DSCH, Micro Wind and Cadence for simulation of VLSI design.

Course Objectives are

- To allow students to practically verify several basic concepts and procedures learned in VLSI I design course.
- To Develop hands-on experience of how certain procedures of design system operation are carried out.
- To help develop necessary skills to carry out system studies using state of the art VLSI design software.

Course Contents:
- Introduction, Tutorial Lab
- Design Combinational logic circuit and Sequential logic circuit
- Design of VLSI multipliers
- Design of Multiply-Accumulate circuits
- Design of Digital Filter
- Design of State Machines
- Design of microprocessor parts (Mini Project)

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain various type of software and background theory
CLO 2	Describe the procedure and steps needed to implement a circuit.
CLO 3	Apply concepts and methods of digital system.
CLO 4	Analyze the results of logic and timing simulation
CLO 5	Formulate a sense of right and wrong.
CLO 6	Devise the quality of teamwork and effective communication skills.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3		X	X	X							
CLO 4		X	X	X	X						
CLO 5									X	X	
CLO 6						X	X	X	X		

Recommended Books

1. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", Prentice Hall Higher Education, 2010,
2. Bhaskar J, "A VHDL Primier", Prentice Hall, 3rd Edition, 1999.
3. Douglas L.Perry, "VHDL:Programming by Example", McGraw-Hill, 2002.
4. Charles H.Roth, Lizy Kurian John, "Digital systems design using VHDL", Thomson, 2008.
5. Weste&Eshraghian, "Principles of CMOS VLSI Design", Addison Wesley, 2nd Edition, 2008.

Course Title: RF and Microwave Engineering	Year/Semester: 4/1	Course Status: Theory (Major, optional)

Course Code: EEE 475	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 229 (Electromagnetic Fields and Waves)		

Rationale:
EEE engineers are expected to know the principles and RF & Microwave engineering and their application in radar and broadcast radio communication systems. In particular, a detailed discussion on transmission lines, waveguides, impedance matching, microwave resonators, RF filters, RF amplifiers, and passive RF and microwave devices (mixers, diplexers, etc.) will be presented in this course. Furthermore, an introduction to antenna design as well RF/microwave communications link design will be provided.

Course objectives are:
- To explain the operation of components and devices used in RF & Microwave systems.
- To explain the principles of design and operation of devices for generation & processing of RF signals at different power levels.
- To teach the applications of RF & microwave systems in communication, control & instrumentation.
- To help develop the skills to design proper antenna for proper communication process.

Course Contents:
Electromagnetic Engineering Antenna Theory and Practice Analytical and Computational Techniques in Electromagnetics, RF and Microwave Circuits and Antenna. RF and Microwave Integrated Circuits. Tuned small-signal amplifiers, mixers and active filters, oscillators; receivers; amplitude modulation; single side-band modulation; angle modulation; digital communications; transmission lines and cables; radio wave propagation; antennae.Spectral analysis; phase locked loops; noise; antennae; cellular radio; meteor burst communications; spread spectrum techniques.
Transmission lines: Voltage and current in ideal transmission lines, reflection, transmission, standing wave, impedance transformation, Smith chart, impedance matching and lossy
transmission lines. Waveguides: general formulation, modes of propagation and losses in parallel plate, rectangular and circular waveguides. Microstrips: Structures and characteristics. Rectangular resonant cavities: Energy storage, losses and Q. Radiation: Small current element, radiation resistance, radiation pattern and properties, Hertzian and half wave dipoles. Antennas: Mono pole, horn, rhombic and parabolic reflector, array, and Yagi-Uda antenna

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Describe basic electromagnetic antenna and RF theory
CLO 2	Explain basic operating principles of RF and microwave integrated circuits.
CLO 3	Describe transmission line characteristic for RF and microwave communication
CLO 4	Explain radiation in RF and microwave communication.
CLO 5	Describe basic operation of waveguides and design microstrip waveguides.
CLO 6	Interpret and utilize smith chart.
CLO 7	Calculate mathematical expression for transmission line and its losses.
CLO 8	Design different types of antennas.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X										
CLO 5	X										
CLO 6		X		X	X						
CLO 7		X		X	X						
CLO 8				X	X				X		

Recommended Books:
1. Microwave devices and Circuits by Samuel Y. Lias
2. Microwave Engineering by P.A. Rizzi
3. Microwave Engineering by David M Pozar
4. Antenna Theory by Constatine A Balanis

Course Title: RF and Microwave Engineering Lab		Year/Semester: 4/1	Course Status: Lab (Major, optional)
Course Code: EEE 476	Credit: 1.5	Contact hours: 3 hours of Lab per week	
Pre-requisite: EEE 229 (Electromagnetic Fields and Waves)			

Rationale:
EEE engineers are expected to know the principles and RF & Microwave engineering and their application in radar and broadcast radio communication systems. In particular, a detailed discussion on transmission lines, waveguides, impedance matching, microwave resonators, RF filters, RF amplifiers, and passive RF and microwave devices (mixers, diplexers, etc.) will be
presented in this course. Furthermore, an introduction to antenna design as well RF/microwave communications link design will be provided. The theoretical knowledge is incomplete without hands on experiments using the basic antenna and RF components. Students learn to design and simulate different kind antennas, and then learn their propagation pattern using laboratory equipment. This course is designed to complement the theoretical course EEE 476.

Course objectivesare:
- To demonstrate operation of components and devices used in RF & Microwave systems.
- To provide the basic concepts related to the principles of design and operation of devices for generation & processing of RF signals at different power levels.

- To help developing skills to design microstrip antennas and explore their propagation pattern via simulation.
- Acquaint students with the applications of RF communication systems.
- Accumulate basic ideas about designing and simulating different antennas.

Course Contents:

1. Performance analysis of half wave dipole antenna.
2. Performance analysis of folded dipole antenna.
3. Performance analysis of Loop antenna.
4. Performance analysis of Yagi-Uda antenna.
5. Performance analysis of Helix antenna.
6. Performance analysis of Slot antenna.
7. Performance analysis of Microstrip antenna.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO	Describe operation and propagation pattern of antennas.
CLO	Identify and interpret different type of antenna.
CLO	Explain components working principle.
CLO	Apply the safety procedures while handling microwave radiation
CLO	Design different type of antennas.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X										
CLO 4			X	X					X	X	
CLO 5			X	X			X	X	X	X	X

Recommended Books:

1. Microwave devices and Circuits by Samuel Y. Lias
2. Microwave Engineering by P.A. Rizzi
3. Microwave Engineering by David M Pozar
4. Antenna Theory by Constatine A Balanis

Course Title: Project/Thesis	Year/Semester: 4/2	Course Status: Lab (Major, Compulsory)
Course Code: EEE 408	Credits: 4.0	Contact hours:8 hours lecture per week
Pre-requisite: None		

Rationale:

This course is a part of B.Sc. (Engg.) program in Electrical and Electronic Engineering.

Course Objectives are

- To understand the basics of doing scientific research
- Be conversant on analysis of scientific data.
- To provide knowledge about how to present scientific work.
- To develop skills to do research along with understanding of the current research questions.
- To make students familiar ethical issues in an adequate manner related to the scientific work.

Course Contents:

The undergraduate thesis /project within the field of Electrical and Electronic Engineering research is an individual study that must include hypothesis testing that will substantiate new data.

The undergraduate thesis/project includes search, studies and summary of scientific literature, practical work in close relation to ongoing Electrical and Electronic Engineering research, compilation and critical analysis of the results, and oral and written presentation.

The undergraduate thesis/project is mastered under individual supervision. The supervision includes how to perform a scientific study and how to orally and in writing present gathered data in good scientific manner. The supervisor must have documented scientific experience.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain basic knowledge on how to pursue scientific fact.
CLO 2	Explain basics of planning and performance of a scientific work.
CLO 3	Explain basics of analysis of scientific data.
CLO 4	Illustrate basic knowledge on how to present scientific work.
CLO 5	Obtain Theoretical and practical professional specialization within Electrical and Electronic Engineering including understanding of the current research questions.
CLO 6	Search scientific literature.
CLO 7	Summarize scientific literature.
CLO 8	Discuss scientific data related to the question at hand.
CLO 9	Present scientific data and conclusions in written and oral form addressed to different groups.
CLO 10	Understand and analyze ethical issues in an adequate manner related to the scientific work.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5			X	X	X	X	X	X	X		X
CLO 6	X	X									
CLO 7		X			X						
CLO 8	X	X				X					
CLO 9						X			X		
CLO 10										X	

Course Title: Power System Protection	Year/Semester: 4/2	Course Status: Theory (Major, compulsory)
Course Code: EEE 445	Credits: 3.0	Contact hours: 3 hours Lecture per Week
Pre-requisite: EEE 337 (Power Systems II)		

Rationale:
This course aims to provide the students with theoretical and practical knowledge on power system protection. It provides an overview of the principles and schemes for protecting power lines, transformers, buses and generators the students will become familiar with the components, basic operating principles, main applications, and limitations of protective relays and protection schemes. The students will also learn strategies to design reliable protection systems. As prerequisites of this course, the students are expected to be familiar with power system analysis.

Course Objectives are
- To develop an understanding of the most common types of protection.
- To help develop necessary skills to apply the theory to a range of practical examples
- To describe the settings of feeder and transformer protection schemes, and selection of current and voltage instrument transformers for those protection schemes.
- To explain the impact of electrical overstress on the design and operation of power systems and electronic equipment and relays that can detect various faults.

Course Contents:
Introduction to power system protection: Purpose of power system protection, requirements of a good protection scheme.
Criteria for detecting faults: Over current, differential current, difference of phase angles, over and under voltages, power direction, symmetrical components of current and voltages, impedance, frequency and temperature.
Introduction to switchgear: Significance of Switchgear, Protection and Power System: Location of Switchgear in Typical Power System, Sub-Station Equipment, Faults and Abnormal Condition, Fault Clearing Process, Protective Relay, Types and importance of
Neutral Grounding, Over Voltage, Electromechanical and Static Relay, Interconnected Power System, Load Frequency control and load Shedding, Voltage Control.
Instrument transformers: Definition and purpose of instrument transformers, types of instrument transformers, Current Transformer and Potential Transformer.
Fuses: Advantages and Disadvantages, Desirable Characteristics of fuse element, Fuse Element, Current Rating of fuse element, Fusing Current, Types of Fuse: Low voltage fuse, High voltage fuse, Difference between fuse and circuit breaker, Coordination of fuse and circuit breaker.

Relays: Function of protective relay, Protective Zones, Primary and Back up protection, Back Up protection by time grading principle, Desirable quantities of protective relays, actuating quantities, Electromagnetic Attraction Relays: Attracted armature type, Balanced beam type, Electromagnetic Induction type, Relay timing: Instantaneous relay, Inverse time relay, Definite time lag relay. Pick up current, Current setting, plug setting multiplier, Time setting multiplier, Time/PSM curve. Induction type Overcurrent Relay, Induction type Directional Power Relay, Induction type Directional Type Over Current Relay, Distance or Impedance Relay: Definite-distance relay, Time distance relay, Differential Relays: Current Differential Relay, Voltage Differential Relay. Non-directional Time and Current grades scheme, Current-Time grading using IDMT, Protection of Ring by Directional O/C Relay, Three Zone Distance Protection
Circuit breakers: Principle of Arc Extinction, Methods of Arc Extinction, Arc Voltage, Re-striking Voltage, Recovery Voltage, Basic Info, Advantages, Disadvantages of following CB: Oil CB, Air Blast CB, SF6 CB, Vacuum CB, Components common to most CB: Bushing, CB Contacts, Instruments Transformers, Bus Bar and conductor, Rate of rise of re-striking voltage, Current Chopping, Capacitive current breaking, Resistance Switching, Making Capacity, Breaking capacity Operation of Miniature CB(MCB) and Molded Case CB(MCCB), Auto Recloser, Dead Time of Auto Reclosure.
Protection of Alternators: Major Faults which may occur on Alternator, Differential Protection of Alternator, Balanced Earth Fault Protection, Stator Inter-turn Protection, Over current protection, Unbalance Loading protection.
Protection of Transformers: Transformer Faults, Buchholz Relay, Earth Fault relays, over current relays, Differential system, Combined Leakage and Overload Protection, Applying Circulating current system to transformer, Circulating current scheme for transformer protection, Tank Earth fault protection.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Describe and categorize different protective equipment or power systems.
CLO 2	Explain the concepts of power system protections, instrument transformers, fundamentals of relaying, overcurrent protection and coordination, directional overcurrent protection, differential protection, distance protection, distributed generation protection.
CLO 3	Identify the economic and environmental challenges to designing a well-protected power system and provide solutions to the problems that maintains the moral and ethical standards from an engineering and societal perspective
CLO 4	Implement the appropriate safety equipment for design of electrical power system with enhancing the efficiency of the transmission and distribution system with environment friendly technology.
CLO 5	Distinguish sensing mechanism of different types of relays and working principle of various circuit breakers and fuses.
CLO 6	Compare bus bar protection systems and use them accordingly

CLO 7	Recognize the need to continuously follow the advancements in protection technology and incorporating them in the present system to improve efficiency.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X									
CLO 4		X									
CLO 5		X		X	X						
CLO 6		X			X						
CLO7		X		X	X						

Recommended Books

1. Principle of Power System by V.K Mehta & Rohit Mehta
2. Switchgear Protection and Power System by Sunil S. Rao
3. Power System Protection by Paul M. Anderson
4. Practical Power System Protection by Leslie Hewitson.

Course Title: Power System Protection Lab	Year/Semester: 4/2	Course Status: Lab (Major, compulsory)
Course Code: EEE 446	Credits: 1.5	Contact hours: 3 hours of Lab per Week
Pre-requisite: EEE 337 (Power Systems II)		

Rationale:

This course provides experimental and project-oriented verification of principles of industrial system design and power system protection. An understanding of the fundamental principles of power system protection remains very essential for engineering students. Theoretical knowledge is incomplete without hands on experiments using the module with all different kinds of relays and simulative tripping options. This course is designed to complement the theoretical course EEE 445.

Course objectives are:

1. To develop an understanding of the most common types of protection.
2. To help develop the skills to apply the theory to a range of practical examples
3. To explain the settings of feeder and transformer protection schemes, and selection of current and voltage instrument transformers for those protection schemes.
4. Foster the analytical and critical knowledge to simulate faulty scenarios with laboratory modules and to observe and calculate tripping time.

Course Contents:

1. Study of Maximum current three phase relay (overload and short-circuit)
2. Study of Maximum or minimum single-phase current relay
3. Study of Maximum and minimum three phase voltage relay
4. Study of Maximum or minimum single-phase voltage relay
5. Study of Phase sequence and voltage asymmetry relay
6. Study of Current directional relay
7. Study of Primary winding asymmetric transformers.
8. Study of Earth leakage protection relay.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Select the methods to choose suitable current transformer, voltage transformer and circuit breakers etc. for fulfilling power system protection.
CLO 2	Identify and compare different protective devices and analyze their performance.
CLO 3	Develop experimental techniques for setting and testing relays and document the obtained data properly.
CLO 4	Develop individual opinion and communicate effectively across the members of the team
CLO 5	Comply as a part of the team to achieve specified and measurable results while performing the experiments.
CLO 6	Evaluate and explain the operation of protective devices from an experimental perspective.
CLO 7	Maintain ethics while collecting and documenting experimental data.

Mapping of Course Learning Outcomes to Program Learning Outcomes-

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X	X	X								
CLO 3			X	X	X						
CLO 4						X					
CLO 5							X				
CLO 6								X	X		X
CLO 7										X	

Recommended Books

5. Principle of Power System by V.K Mehta & Rohit Mehta
6. Switchgear Protection and Power System by Sunil S. Rao
7. Power System Protection by Paul M. Anderson
8. Practical Power System Protection by Leslie Hewitson
9. **Lab Manual:** Will be supplied by course teacher in the beginning of the course and also available in website.

Course Title: Cellular Mobile and Satellite Communication	Year/Semester: 4/2	Course Status:Theory (Major, optional)
Course Code: EEE 485	Credit: 3.0	Contact hours: 3 hours Lecture per week
Pre-requisite: EEE 329 (Basic Communication Engineering) and EEE 330 (Basic Communication Engineering Lab)		

Rationale:

This course introduces the basic theory and the knowledge of different fields required in digital communication. Also, communication techniques in fading channels are discussed. A detailed discussion on wireless communication systems is given, and ability to design simple
communication receivers is created. Much attention is given to standards and application of cellular concepts. This course will help the students to learn about the Satellite communication as well as the basic operation of the required components.

Course objectives are:

- To provide students with a good understanding of the fundamental principles underlying the theory of wireless communication systems, multipath fading effects and their mitigation techniques, with emphasis on cellular mobile and satellite communication systems.
- To help students identify the challenges of mobile communications.
- Acquaint students with the engineering solutions that have been developed to create commercial cellular networks.
- To introduce the field of satellite communications.

Course Contents:

Cellular and Mobile Communication: Introduction to code divisions Multiple Access (CDMA), Basic concepts, Spread spectrum, DS (Direct sequence) spread spectrum, Reverse link DSCDMA, forward link DS-CDMA, Cellular systems, GSM, AMPS, Cellular digital packet data. CDMA Air links**:** Pilot channel, Synchronous channel, Paging channel, Traffic channel, Free space propagation, Propagation model, Multi path propagation, Propagation environment, Marine environment.Historical developments of Mobile Telephony, Trunking efficiency, Propagation criteria, mobile ratio environment, Elements of cellular radio system design, Specifications, Channel capacity, Cell coverage for signal and traffic, Mobile propagation models and fading models, Interference effects, Power control, Mobile switching and traffic, Mobile switching system and its subsystems, Mobile communication protocols.

Satellite Communication: Introduction, Types of Satellites, Orbits, Station keeping, Satellite altitude, Transmission path, Path losses, Noise considerations, Satellite systems, Saturation flux density, Effective isotropic radiated power, Multiple access methods.Introduction: Principle, evolution, networks, exchange and international regulatory bodies. Telephone apparatus: Microphone, speakers, ringer, pulse and tone dialing mechanism, side-tone mechanism, local and central batteries and advanced features. Switching system: Introduction to analog system, digital switching systems – space division switching, blocking probability and multistage switching, time division switching and two dimensional switching. Traffic analysis: Traffic characterization, grades of service, network blocking probabilities, delay system and queuing. Modern telephone services and network: Internet telephony, facsimile, integrated services digital network, asynchronous transfer mode and intelligent networks. Introduction to cellular telephony and satellite communication.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-

CLO 1	Explain cellular and mobile communication basics.
CLO 2	Describe different layers of Open System Interaction model.
CLO 3	Interpret different propagation models.
CLO 4	Calculate channel capacity, channel traffic and power.
CLO 5	Distinguish various types of satellites, satellite orbits, transmission path and satellite systems.
CLO 6	Explain the switching system operation.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X									
CLO 4		X			X						
CLO 5		X									
CLO 6	X										

Recommended Books:

1. Satellite Communication Systems-Gerard Marat & Michel Bousquet.
2. Communication Engineering- Theody. S. Rapaport.
3. Ericsson GSM System Survey

Course Title: Electrical Machines III	Year/Semester: 4/1	Course Status:Theory (Major, optional)
Course Code: EEE 439	Credits: 3.0	Contact hours: 3 hours Lecture per Week
Pre-requisite: EEE 225 (Electrical Machines II)		

Rationale:

This course is a continuation of the course EEE 225 (Electrical Machines II). It covers an array of special machines, acyclic machines, photovoltaic systems and wind turbine generators. This course examines the basic theory, characteristics, construction operation and application of these machines. The course also aims at providing a basic understanding of theory and practice of various wind turbine and photovoltaic technologies and design concepts. The course further focuses on developing an understanding of operational aspects of system design and finally analyze the performance.

Course Objectives

- To make the students understand the basic concepts of special machines, acyclic machines, photovoltaic systems and wind turbine generators.
- To provide knowledge about the performance of special machines, acyclic machines, photovoltaic systems and wind turbine generators in operation and establish measures to improve their power efficiency.
- To help students develop necessary skills to calculate and analyze the economic feasibility of energy production using a wind turbine from wind speed distribution, wind shear and power curve.

Course Content:

Special machines: series universal motor, permanent magnet DC motor, unipolar and bipolar brush less DC motors, stepper motor and control circuits. Reluctance and hysteresis motors with drive circuits, switched reluctance motor, electrostatic motor, repulsion motor, synchronous and control transformers. Permanent magnet synchronous motors.
Acyclic machines: Generators, conduction pump and induction pump. Magneto hydrodynamic generators. Fuel Cells, thermoelectric generators, flywheels. Vector control, linear motors and traction.
Photovoltaic systems: Stand alone and grid interfaced.
Wind turbine generators: Induction generator, AC-DC-AC conversion, Linear Motors, Levitation.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Identify, describe and analyze the situation and characteristics of the various energy resources and end uses of energy, in their economic, social and environmental dimensions, and to make value judgments.
CLO 2	Explain the basic theory, characteristics, construction operation and application of special machines, acyclic machines, photovoltaic systems and wind turbine generators.
CLO 3	Describe and analyze the entire energy conversion chain of photovoltaic systems and wind turbines.
CLO 4	Analyze the performance of these machines in operation and establish measures to improve their power efficiency.
CLO 5	Calculate and analyze the economic feasibility of energy production using a wind turbine from wind speed distribution, wind shear and power curve.
CLO 6	Predict wind turbines influence the environment and are influenced by the environment, as well as make calculations related to environmental impact.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X		X							
CLO 4		X		X	X						
CLO 5		X		X	X						
CLO 6		X			X						

Recommended Books
1. Energy conversion by Kenneth C. Weston
2. Energy conversion: systems, flow physics and engineering by Professor Reiner Decher

Course Title: Power Plant Engineering	Year/Semester: 4/1	Course Status: Theory (Major, optional)
Course Code: EEE 443	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 337 (Power System II)		

Rationale
Power plant engineering is a subfield of electrical engineering that deals with the generation, transmission, distribution and utilization of electric power, and the electrical apparatus connected to such systems. This course deals with the generation part of power engineering.

Course Objectives are
- To describe sources of energy and types of power plants.
- To help students develop necessary skills to analyze different types of steam cycles and estimate efficiencies in a steam power plant.
- To provide students necessary concepts to list types, principles of operations, components and applications of steam turbines, steam generators, condensers, feed water and circulating water systems.
- To describe basic working principles of hydro-electric, gas turbine and diesel engine power plants.
- To explain the performance characteristics and components of such power plants.
- To describe the principal components and types of nuclear reactors.
- To help students develop necessary skills to evaluate cycle efficiency and performance of various nuclear power plant.
- To help students develop necessary skills to classify different types of coupled vapor cycles and list the advantages of combined cycle power plant.
- To explain the terms and factors associated with power plant economics.
- To help students develop necessary skills to calculate present worth, depreciation and cost of different types of power plants.
- To help students develop necessary skills to estimate the cost of producing power per kW

Course Contents:
Power plants: general layout and principles, steam turbine, gas turbine, combined cycle gas turbine, hydro and nuclear power plant instrumentation.
Selection of location: Technical, economic and environmental factors, Load forecasting.
Generation scheduling: deterministic and probabilistic.
Electricity tariff: formulation and types.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Identify the major types of diesel power plant and estimate power generation potential.
CLO 2	Explain the blade shapes and calculate work output of typical turbine stages.
CLO 3	Outline the basic principles of thermal-fission and fast-breeder nuclear power plants, such as pressurized-water, boiling-water, and heavy-water reactors.
CLO 4	Discuss the energy resources and energy conversion methods available to produce electric power in Bangladesh

CLO 5	Determine the efficiency and output of a modern Rankine cycle steam power plant from given data, including superheat, reheat, regeneration, and irreversibility
CLO 6	Calculate the heat rate, fan power consumption, flame temperature and combustion air requirements of conventional steam generators (boilers).
CLO 7	Interpret the electricity tariff system
CLO 8	Calculate the performance of gas turbines with reheat and regeneration and discuss the performance of combined cycle power plants.
CLO 9	Distinguish the major types of hydropower and wind-power turbines and estimate power generation potential.
CLO 10	Select the heat transfer tubes needed for condensers and feed water heaters

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X										
CLO 5				X	X						
CLO 6				X	X						
CLO 7		X									
CLO 8				X	X						
CLO 9		X									
CLO 10		X									

Recommended Books

1. Power Plant Engineering by G.R. Nagpal
2. Principles of Power System by V.K. Mehta and Rohit Mehta
3. Power Station Engineering and Economy by Bernhardt G.A. Skrotzki, William A. Bhopat

Course Title: Processing and Fabrication Technology	Year/Semester: 4/1	Course Status: Theory (Major, optional)
Course Code: EEE 453	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 421 (Solid State Devices)		

Rationale

The course covers process technologies that are used in micro- and nanofabrication of devices and systems on wafers. Applications include all technologies that are based on wafer scale fabrication such as integrated circuits, micro-electro-mechanical systems and optical devices. The basic unit processes deposition, patterning, etching, doping and heat treatment are covered, followed by process integration to build complex devices. Moore's law and the basic economics for integrated circuits are covered and exemplified by reviewing the state-of-the art process technology nodes. The course gives the student basic understanding of the sustainability aspects in integrated circuit fabrication.

Course Objectives are:

- To introduce technology and processes those are used in fabricating advanced electronic devices and circuits.
- To make students familiar with the unit process technology.
- Accumulate basic ideas about doping processes.
- Facilitate necessary knowledge about lithography.
- To provide the knowledge of integrated circuit packaging and testing.

Course Contents:

Substrate materials: Crystal growth and wafer preparation, epitaxial growth technique, molecular beam epitaxy, chemical vapor phase epitaxy and chemical vapor deposition (CVD).

Doping techniques: Diffusion and ion implantation. Growth and deposition of dielectric layers: Thermal oxidation, CVD, plasma CVD, sputtering and silicon-nitride growth.

Etching: Wet chemical etching, silicon and GaAs etching, anisotropic etching, selective etching, dry physical etching, ion beam etching, sputtering etching and reactive ion etching.

Cleaning: Surface cleaning, organic cleaning and RCA cleaning.

Lithography: Photo-reactive materials, pattern generation, pattern transfer and metallization.

Discrete device fabrication: Diode, transistor, resistor and capacitor.

Integrated circuit fabrication: Isolation - pn junction isolation, mesa isolation and oxide isolation. BJT based microcircuits, p-channel and n-channel MOSFETs, complimentary MOSFETs and silicon on insulator devices. Testing, bonding and packaging.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain various unit-processes in micro/nano fabrication
CLO 2	Analyze, compare and finally gain theoretical experience for the advantages and limitations of different fabrication processes.
CLO 3	Design a device using the fabrication processes.
CLO 4	Evaluate the better way of fabrication.
CLO 5	Describe process integration examples.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2		X		X							
CLO 3				X	X						
CLO 4					X						
CLO 5		X									

Recommended Books

1. Semiconductor Technology: Processing and Novel Fabrication Techniques by Michael E. Levinshtein, Michael S. Shur
2. Microelectronic Fabrication by William J Campbell

Course Title: Compound Semiconductor and Hetero-Junction Devices	Year/Semester: 4/1	Course Status: Theory (Major, optional)
Course Code: EEE 459	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 421 (Solid State Devices)		

Rationale
The course is an introduction to the binary and ternary compound semiconductor and formation of hetero-junction devices using these semiconductors, advance level to that of homo-junction devices introduced earlier in Solid State Devices course. The characteristics and properties will be discussed in details and this knowledge will be directed to emerging application of semiconductor industry and optoelectronic devices.

Course Objectives are
1. To explain compound semiconductor fundamentals and mobility for charge carriers in these semiconductors.
2. To facilitate necessary knowledge to analyze basic functions of nonlinear devices like p-n junctions, metal-semiconductor junctions, MESFETs, JFETs and Schottky diodes.
3. To help students conceptualize the working principle and design parameter of hetero-junction.
4. To help students develop necessary skills to apply the knowledge of hetero-junction for devices like HEMT, HBT and TEBT.
5. Acquaint students with skills to apply the knowledge of device parameters to improve device/circuit performance.

Course Contents:
Compound semiconductor: Zinc-blend crystal structures, growth techniques, alloys, band gap, density of carriers in intrinsic and doped compound semiconductors, Band Structure, Effective Mass Calculation.
Hetero-Junctions: Band alignment, band offset, Anderson's rule, single and double sided hetero-junctions, quantum wells and quantization effects, Low Dimensional Band Structure: DOS of Quantum Wells, Wires and Dots, lattice mismatch and strain and common hetero-structure material systems, effect of strain on critical thickness and effective masses for hetero structure.
Hetero-Junction diode: Band banding, carrier transport and I-V characteristics.
Hetero-junction field effect transistor: Structure and principle, band structure, carrier transport and I-V characteristics.
Hetero-structure bipolar transistor (HBT): Structure and operating principle, quasi-static analysis, extended Gummel-Poon model, Ebers-Moll model, secondary effects and band diagram of a graded alloy base HBT.

Some Common Hetero-Junction Devices:MESFET(metal–semiconductor field-effect transistor), HEMT(High Electron Mobility transistor), JLLNWFET(Junction -less Nanowire Field Effect Transistor).
Tunnel FET: Introduction, band diagram, qualitative theory of operation, pinch-off voltage and current-voltage relationship.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Define basic concepts of compound semiconductor fundamentals.
CLO 2	Describe basic alloy structures.
CLO 3	Explain the basic theoretical concepts of metal-semiconductor junction and shcottky diodes.
CLO 4	Apply the knowledge of properties for theoretical small signal modeling of HBT, HEMT and TEBT.
CLO 5	Analyze hetero-junctions and its property
CLO 6	Design hetero devices considering environmental sustainability.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5				X							
CLO 6				X	X						

Recommended Books
1. Semiconductor Physics and Devices Basic Principles by Donald A. Neamen
2. Semiconductor Optoelectronic Devices by Pallab Bhattacharya
3. Compound semiconductor electronics: the age of maturity, by M Shur
4. Solid State Electronic Devices by Ben G. Streetman and Sanjay Banerjee

Course Title: Optoelectronics	Year/Semester: 4/2	Course Status: Theory (Major, optional)
Course Code: EEE 465	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 221 (Electronics I), EEE 421 (Solid State Devices)		

Rationale
This course is an introduction to the properties of light and implementation of these properties for the fabrication and design of optoelectronic devices using the concept of homo-junction and hetero-junction already taught in Solid State Devices and Compound Semiconductor and Hetero-junction Devices courses. The working principle of LEDs, LASERs, Photo-diodes, Solar cell and modulators will be discussed in details.

Course Objectives are
- To explain the fundamental theory and properties of light.

- To facilitate necessary knowledge to analyze the function of band-gap for optical devices and different type of transitions along with the formation of strain and its significance.
- To acquaint students with the working principle and design parameter of Photonic Crystals.
- To develop skills for designing devices like LEDs, LASERs and solar cell.
- To understand the polarization of light and study different types of modulator.

Course Contents:

Optical properties in semiconductor: Direct and indirect band-gap materials, radiative and non-radiative recombination, optical absorption, photo-generated excess carriers, minority carrier life time, luminescence and quantum efficiency in radiation.

Properties of light: Particle and wave nature of light, polarization, interference, diffraction and blackbody radiation.

Light emitting diode (LED): Principles, materials for visible and infrared LED, internal and external efficiency, loss mechanism, structure and coupling to optical fibers.

Stimulated emission and light amplification: Spontaneous and stimulated emission, Einstein relations, population inversion, absorption of radiation, optical feedback and threshold conditions.

Semiconductor Lasers: Population inversion in degenerate semiconductors, laser cavity, operating wavelength, threshold current density, power output, hetero-junction lasers, optical and electrical confinement. Introduction to quantum well lasers.

Photo-detectors: Photoconductors, junction photo-detectors, PIN detectors, avalanche photodiodes and phototransistors.

Solar cells: Solar energy and spectrum, silicon and Schottkey solar cells.

Modulation of light: Phase and amplitude modulation, electro-optic effect, acousto-optic effect and magneto-optic devices. Introduction to integrated optics.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain basic concepts and properties of light.
CLO 2	Describe the working principle of optoelectronic devices like LEDs, LASERs and photo-detectors.
CLO 3	Apply properties of light in semiconductor for modeling solar cells.
CLO 4	Design and analyze Photonic Crystals.
CLO 5	Design sustainable and environment friendly technology.
CLO 6	Describe the working principles of different types of modulators and be able to use for specific purposes.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X	X									
CLO 4				X	X						
CLO 5				X	X						
CLO 6				X	X						

Recommended Books

1. Optoelectronics and Photonics: Principles and Practices by S.O. Kasap
2. Semiconductor Optoelectronic Devices by Pallab Bhattacharya
3. Optoelectronics: an introduction by John Wilson and John Hawkes
4. Physics of Semiconductor Devices by Simon M. Sze and Kwok K. Ng

Course Title: Optical Fiber Communication	Year/Semester: 4/2	Course Status: Theory (Major, optional)
Course Code: EEE 481	Credits: 3.0	Contact hours: 3 hours lecture per week
Pre-requisite: EEE 329 (Basic Communication Engineering), EEE 330 (Basic Communication Engineering Lab)		

Rationale:

EEE students need to have a broad idea in networking and communication. Fiber optics is an integral part of communication besides the field of electronics is rapidly changing into opto-electronics. This course will help the students to learn about the optical communication as well as the basic operation of the required components.

Course Objectives are

- To understand the basic optics for wave guide transmission.
- Be conversant on optical waveguide components, including single and multimode fiber, fiber couplers, connectors, and fiber amplifiers.
- To provide knowledge about fabrication and characterization of optical fiber.
- To make students familiar with the components used in optical communications like, lasers, photodiodes, couplers and fiber amplifiers.
- To help students conceptualize about detection techniques and noise analysis.
- To develop skills to design a fiber optic network.

Course Contents:

Optical fiber as wave-guides: Ray theory, Modes, SMF, MMF, Step Index and graded Index Fiber, **Transmission Characteristic**: Attenuation, Dispersion, Polarization, **Fabrication**: Liquid phase, Vapor phase, Fiber Cables, **Connectors and Couplers:** Alignment and joint loss, Splices, GRIN rod lens, Connectors, Couplers, **Optical Source:** LASER, semiconductor injection LASER, LASER characteristic, modulation **Optical Detectors:** Photodiode construction, characteristic, P-N, P-I-N, APD, **Direct Detection:** Noise, Eye diagram, Receiver design, **Fiber Amplifier:** Construction, characteristic, use, **Digital Transmission System:** Point to point link, power budget, Noise, **Advanced Systems and Techniques:** WDM, Photonic switching, All optical network.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain advantage of fiber optic communication quantitatively.
CLO 2	Describe the fabrication techniques of Optical Fiber.

CLO 3	Explain basics of optical component and opto-electronics.
CLO 4	Explain characteristics of optical sources and detectors and Compare the different types of optical amplifier in basis of their principles and applications, Receiver analysis.
CLO 5	Illustrate the basic knowledge of Ray optics theory and Explain the Transmission Characteristics of fiber
CLO 6	Solve the challenges in Fiber Optic communication.
CLO 7	Design Fiber-optic network.
CLO 8	Estimate errors in transmission.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X	X									
CLO 5	X	X									
CLO 6				X	X						
CLO 7				X	X						
CLO 8				X	X						X

Recommended Books

1. Optical Fiber Communication by John M. Senior
2. Fiber-Optic Communications by Govind P. Agrawal
3. Optical Fiber Communications by Gerd Keiser

Course Title: Optical Fiber Communication Lab	Year/Semester: 4/2	Course Status: Lab (Major, optional)
Course Code: EEE 482	Credits: 1.5	Contact hours: 3 hours of Lab per Week
Pre-requisite:EEE329 (Basic Communication Engineering), EEE330 (Basic Communication Engineering Lab)		

Rationale:

This course provides the student a broad idea in optical communication and networking. Fiber optics is an integral part of modern communication systems. Besides, the field of electronics is rapidly changing into opto-electronics. The theoretical knowledge is incomplete without hands
on experiments using the basic components and measuring devices used in fiber optic communication. This course is designed to complement the theoretical course EEE 481.

Course objectives are:

- To facilitate necessary knowledge of basic optics using optical fiber.
- To acquaint students with the basic components used in fiber optic communication
- To enhance the skill of using measurement devices in fiber optic communication.
- To help students accumulate basic ideas about attenuation and modal behavior of optical fiber.
- To facilitate necessary knowledge about the measurement of bit error in fiber optic communication.

Course Contents:

1. Physical Characterization of Optical Fiber and Diode Laser.
2. Multimode Behavior of a Fiber.
3. Measurement of Bend Loss in SMF.
4. Study of an Optical Attenuator.
5. Performance of a Laser and it's temperature dependence.
6. Construction of a Power Meter
7. Bit Error Rate (BER) measurement.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Identify the physical size of the optical fiber and laser diode.
CLO 2	Explain the students that light does move only in allowed modes in a fiber
CLO 3	Operate a real laser and generate its temperature characteristics
CLO 4	Demonstrate the important property "Bend Loss" in a single mode fiber.
CLO 5	Design the construction of an optical attenuator.
CLO 6	Develop the knowledge of op-amp and logarithmic amp and construct a power meter.
CLO 7	Interpret the fundamental BER plot of a fiber optic communication system.

Mapping of Course Learning Outcomes to Program Learning Outcomes-

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X	X									
CLO 2	X										
CLO 3			X	X	X						
CLO 4			X	X							
CLO 5				X			X	X	X	X	
CLO 6				X	X		X	X	X	X	
CLO 7				X	X						

Recommended Books

1. Optical Fiber Communications by John M. Senior
2. Optical Fiber Communications by Gerd Kaiser
3. Fiber Optic Communications Technology by Djafar K. Mynabaev and Lowell L. Scheiner
4. Optical Communications Network by Biswanath Mukherjee

Lab Manual: Will be supplied by course teacher in the beginning of the course and also available in website.

Non-Major Courses
(Offered for other departments)

Course Title: Basic Electrical and Electronic Circuits	Year/Semester: 1/1	Course Status: Theory
Course Code: EEE 101W	Credits: 3.0	Contact hours: 3 hours lecture per week

Rationale

This is an introductory course which gives athorough idea on different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks including the use of phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices.

Course Objectives are

- To facilitate the basic concepts of electrical charge, voltage, current and power
- To help students develop basic knowledge of DC circuit behavior.
- To acquaint students with basic theorems of circuit analysis.
- To help students conceptualize about basic AC circuit.
- Accumulate basic ideas about diode, transistors, op-amps and their applications
- To facilitate the basic concepts of Boolean algebra and logic gates.
- Foster the analytical knowledge to design and analyze combinational and sequential circuits.

Course Contents:

Voltage, Current, Power, Energy, Dependent and Independent Sources, Ohm's law, Series-Parallel circuits, Voltage division and current division, KVL, KCL, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Norton's Theorem, Maximum Power Transfer Theorem, Capacitors, Inductors, RC, RL Transients, Sinusoidal Wave form, Phasors, RC, RL, RLC Circuits. Diodes, Transistors, FET Simple Biasing, Op-amps and Basic operations, Logic gates, Logic circuits.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the Basic concepts of Electrical Circuits.
CLO 2	Describe the idea of AC networks and phasor.
CLO 3	Explain the basics of diode, transistors, op-amps and their applications
CLO 4	Describe the basic concepts of logic gates
CLO 5	Solve and Analyze the electrical circuits using different analysis methods and theorems
CLO 6	Use basic functional & timing (clocking) properties of latches & flip-
CLO 7	Implement simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.
CLO 8	Analyze synchronous sequential circuits to extract next state/output
CLO 9	Analyze combinational circuits

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1	X							
CLO 2	X	X						
CLO 3	X	X						
CLO 4	X	X						
CLO 5	X				X			
CLO 6	X							
CLO 7	X	X		X				
CLO 8	X	X		X				
CLO 9					X			

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku Introductory Circuit Analysis by Robert L. Boylestad
2. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
3. Microelectronic Circuits- Sedra/Smith
4. Digital logic and Computer Design – M. Morris Mano

Course Title Basic Electrical and Electronic Circuits Lab		Credits: 1.5	Course Status: Lab
Course Code: EEE 102W	Year/Semester: 1/1	Contact hours: 3 hours lab per week	

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-101W. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits. This is an introductory experimental laboratory that explores the design, construction, and debugging of analog electronic circuits. It contains experiments of investigating the performance characteristics of diodes, transistors, including the construction of a small audio amplifier and preamplifier. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean Algebra, Logic Circuits, Logic Minimization Techniques, Multiplexers, Adders, Flip-Flops, Counters and Registers.

Course Objectives are:

- To facilitate students with necessary knowledge of real-life dc circuits.
- Acquaint the students with the techniques of solving of different types of circuits by network theorem.
- To provide basic knowled ge about voltage, current and load relationship in a network.
- To help students develop basic skills for transient analysis and steady state analysis of a capacitor and inductor network.
- To help students conceptualize about basic AC circuit.

- Accumulate basic knowledge about the basics of diode, transistors, op-amps and their applications
- To facilitate the basic concepts of Boolean algebra and logic gates.
- Foster the analytical knowledge to design and analyze the combinational and sequential circuits.

Course Contents:
DC Circuits, Rectifying Circuits using Diodes, Clipping Circuit using Diodes, Transistors in Switching Circuit, Transients in RC and RL, AC Circuits, LC Resonance, Op-amp: Inverted Gain, Differentiation and Integration, Logic Circuits, SR Flipflops, Project using Shift register and Counter.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic idea about different types of electrical instruments and measuring devices
CLO 2	Describe the operation of BJT, JFET, MOSFET and OP-amp.
CLO 3	Describe the operation of different amplifier circuits
CLO 4	Build AC electrical circuits on breadboard and perform measurements with electronic test equipment.
CLO 5	Employ network theorems and laws for different types of circuit analysis.
CLO 6	Interpret the transient response of capacitor and inductor circuits
CLO 7	Analyze combinational circuits
CLO 8	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 9	Analyze synchronous sequential circuits to extract next state/output functions practically
CLO 10	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1			X					
CLO 2		X	X					
CLO 3		X	X	X				
CLO 4		X	X	X				
CLO 5			X					
CLO 6		X	X	X				
CLO 7		X	X	X				
CLO 8		X	X	X				
CLO 9		X	X					
CLO 10							X	X

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku Introductory Circuit Analysis by Robert L. Boylestad
2. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
3. Microelectronic Circuits- Sedra/Smith

4. Digital logic and Computer Design – M. Morris Mano

Course Title: Basic Electrical and Electronic Circuits		Year/Semester: 1/1	Course Status: Theory
Course Code: EEE 105F	Credits: 3.0	Contact hours:3 hours lecture per week	

Rationale
This is an introductory course which gives a thorough idea on different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks including the use of phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices.

Course Objectives are:
- To facilitate the basic concepts of electrical charge, voltage, current and power
- To help students develop basic knowledge of DC circuit behavior.
- Acquaint the students with the techniques of solving of different types of circuits by network theorem.
- To help students conceptualize about basic AC circuit.
- Accumulate basic knowledge about the basics of diode, transistors, op-amps and their applications
- To develop students skills for analysis and design of analogue circuits such as amplifiers.
- To develop the skills to solve mathematical problems of simple and complex electrical circuits.
- To introduce the basic principle operations, device and circuit characteristics of diodes and BJT, JFET and MOSFET transistors.
- To provide the basic idea about semiconductor theory
- To facilitate the basic concepts of Boolean algebra and logic gates.

Course Contents:
Voltage and Current, Power and Energy, Ohm's law, Series-Parallel circuits, Voltage division and current division, KVL, KCL, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Maximum power transfer, Source transformation, Capacitors and Inductors with series parallel connection, Sinusoidal alternating wave forms, phasor diagram ,phase relation.
Diode construction, I-V characteristics of diode, half and full wave rectifier, series-parallel configuration of diode, Bipolar junction transistor construction, common emitter, common base,
common collector configuration, operating point of BJT, Fixed bias circuit, Emitter stabilized bias circuit, Voltage divider bias.
Binary logic, Boolean algebra, De Morgan's theorem, Basic Logic gates, Universal gates.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the Basic concepts of Electrical Circuits.
CLO 2	Describe the idea of AC networks and phasor.
CLO 3	Explain the basics of diode, transistors, op-amps and their applications
CLO 4	Describe the basic concepts of logic gates
CLO 5	Solve and Analyze the electrical circuits using different analysis methods and theorems
CLO 6	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 7	Implement simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.
CLO 8	Analyze synchronous sequential circuits to extract next state/output functions
CLO 9	Analyze combinational circuits

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X										
CLO 3	X										
CLO 4	X										
CLO 5	X										
CLO 6	X	X									
CLO 7	X	X			X						
CLO 8	X				X						
CLO 9	X	X			X						

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith
5. Digital logic and Computer Design – M. Morris Mano

Course Title: Basic Electrical and Electronic Circuits Lab	Year/Semester: 1/1	Course Status: Lab
Course Code: EEE 106F	Credits: 1.5	Contact hours: 3 hours lab per week

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-105F. Theoretical knowledge is incomplete without hands-on experiments using the basic components and measuring devices used in electrical circuits' analysis. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits. It contains experiments of investigating the performance characteristics of diodes and different types of diode circuits. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean algebra, Logic Circuits, and Logic Minimization Techniques.

Course Objectives are

- To facilitate students with necessary knowledge of real-life dc circuits.
- Acquaint the students with the techniques of solving of different types of circuits by network theorem.
- To provide basic knowledge about voltage, current and load relationship in a network.
- To develop knowledge of diode, transistors, op-amps and their applications
- To facilitate the basic concepts of Boolean algebra and logic gates.

Course Contents:

- Use of measuring Equipment: Multi-meter, Frequency meter and Oscilloscope
- Test of Ohm's Law plot of I-V, P-V curve
- Verification of KVL
- Verification of KCL
- Determination of Thevenin's equivalent circuit
- Verification of superposition theorem
- Making AND/OR gates using diode/ transistors
- Making half wave and full wave rectifier
- To construct and study the following logic gates: AND, OR, NOT. NAND, NOR, EXOR
- Verify the DE Morgan's Law: Law(I) and Law (II)
- To Verify different kind of applications of Boolean algebra.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic operation of different types of electrical instruments and measuring devices.
CLO 2	Describe the characteristics of diode.
CLO 3	Use network theorems and laws for different type of circuit analysis.
CLO 4	Construct different rectifier circuits.
CLO 5	Manipulate logic expressions using binary Boolean algebra.
CLO 6	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1			X	X							
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5			X	X							
CLO 6							X			X	

Recommended Books

01. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. SadikuIntroductory Circu Analysis by Robert L.Boylestad

02. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesk
03. Microelectronic Circuits- Sedra/Smith
04. Digital logic and Computer Design – M. Morris Mano

Course Title: Electrical Circuits	Year/Semester: 1/1	Course Status: Theory
Course Code: EEE 109D	Credits: 3.0	Contact hours: 3 hours lecture per week

Rationale
This is an introductory course which gives a thorough idea on different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks including the use of phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices.

Course Objectives are:
- To disseminate knowledge about electrical charge, voltage, current and power.
- To give the idea of basic concepts of DC circuit behavior.
- Help the students to conceptualize with the basic theorems of circuit analysis.
- To help the students develop skills to solve mathematical problems of simple and complex electrical circuits.
- To familiarize the students with the basics of AC networks.
- To teach the modeling and analysis of single phase RLC circuits for impedances, voltages, currents, powers and phase shift.

Course Contents:
Circuit variables and elements: Voltage, current, power, energy, independent and dependent sources, and resistance.
Basic laws: Ohm's law, Kirchhoff's current and voltage laws.
Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.
Techniques of circuit analysis: Nodal and mesh analysis including super node and super mesh.
Network theorems: Source transformation, Thevenin's, Norton's and superposition theorems with applications in circuits having independent and dependent sources, maximum power transfer condition and reciprocity theorem.
Energy storage elements: Inductors and capacitors, series parallel combination of inductors and capacitors.
Responses of RL and RC circuits: Natural and step responses.
Sinusoidal functions: Instantaneous current, voltage, power, effective current and voltage, average power, phasors and complex quantities, impedance, real and reactive power, power factor.
Analysis of single-phase AC circuits: Series and parallel RL, RC and RLC circuits, nodal and mesh analysis, application of network theorems in AC circuits.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Define charge, current, voltage and power, resistance etc.
CLO 2	Explain the basic of energy storage elements.
CLO 3	Describe basic AC circuit concepts and responses.
CLO 4	Interpret the basic circuit laws and circuit analysis techniques.
CLO 5	Apply different Network Theorems.
CLO 6	Apply network techniques to AC circuits and networks
CLO 7	Design DC circuit and analyze them.
CLO 8	Design RLC circuits and analyze them.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1	X							
CLO 2	X	X						
CLO 3	X	X						
CLO 4	X	X						
CLO 5	X							
CLO 6	X							
CLO 7					X			
CLO 8					X			

Recommended Books
1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O.
2. SadikuIntroductory Circuit Analysis by Robert L.Boylestad.

Course Title: Electrical Circuits Lab	Year/Semester: 1/1	Course Status: Lab
Course Code: EEE 110D	Credits: 1.5	Contact hours: 3 hours lab per week

Rationale
In this course students will perform experiments to verify practically the theories and concepts learned in EEE-109D. Theoretical knowledge is incomplete without hands-on experiments using the basic components and measuring devices used in electrical circuits' analysis. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits. It contains a broad idea of single-phase power systems with various resistive and reactive loads. It also makes familiar about the relationship between real, apparent and reactive power - including the use of phasor and impedance diagrams, methods of measuring power, calculation of power factor.

Course Objectives are
- To provide the students with capability of implementing different real-life dc circuits.
- To provide the students with the techniques of solving of different types of circuits by network theorem.
- To teach the voltage, current and load relationship in a network.
- To facilitate necessary knowledge about transient analysis and steady state analysis of a capacitor and inductor network.

- Helping the students to develop ability in building AC electrical circuits and perform experiments on them.

Course Contents:
In this course students will perform experiments to verify practically the theories and concepts learned in EEE-109.

- To familiarize students with the operation of different electrical instruments.
- To verify the following theorems:
- KCL and KVL theorem,
- Superposition theorem,
- Thevenin's theorem,
- Norton's theorem and
- Maximum power transfer theorem
- RL and RC response.
- Study the frequency response of an RLC circuit and find its resonant frequency.
- Basic electrical element like fan, bulb, calling bell etc connection from 220v AC single phase supply.
- Relevant application based on EEE 109D.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Differentiate different types of electrical instruments and measuring
CLO 2	Design experiments to interpret different types of circuit analysis theorem and laws
CLO 3	Impart the idea about complex circuit network.
CLO 4	Interpret transient response about capacitor and inductor circuits
CLO 5	Design AC electrical circuits on breadboard and perform measurements with electronic test equipment.
CLO 6	Demonstrate team-based communication skills and apply these in practical life

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1	X							
CLO 2	X							
CLO 3	X							
CLO 4	X	X						
CLO 5		X						
CLO 6						X		X

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L.Boylestad

Course Title: Electronic Devices and Circuits	Year/Semester:1/2	Course Status: Theory
Course Code: EEE 111D	Credits: 3.0	Contact hours: 3 hours lecture per week

Rationale
This course endeavors to build on this knowledge and further expand students' skill in analyzing and designing analogue circuits involving transistors and diodes. The course covers: the basic principles of operation and device characteristics of diodes, Bipolar Junction Transistors (BJT), Junction Field Effect Transistors (JFET) and Metal Oxide Semiconductor Field Effect Transistors (MOSFET) that underpin the analysis, design and implementation of analogue circuits. Multi-stage amplifiers using BJT and FETs further enhanced the course. Upon completion, students should be able to construct, analyze, verify, and troubleshoot analog circuits using appropriate techniques and test equipment.

Course Objectives are:

- Acquaint the students with basic principle operations, device and circuit characteristics of diodes, BJT, JFET, MOSFET and Op-Amp.
- To enhance skill and knowledge in analysis and design of analogue circuits such as amplifiers.
- To facilitate necessary knowledge about DC and AC analysis of different amplifier circuits.
- To help students conceptualize semiconductor theory.

Course Contents:
P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode, Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor, characteristics of a Zener diode, clamping and clipping circuits.
Bipolar Junction Transistor (BJT) as a circuit element: current components, BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch.
Metal Oxide Semiconductor Field Effect Transistor (MOSFET) as circuit element: structure and physical operation of an enhancement MOSFET, threshold voltage, Body effect, current-voltage characteristics of an enhancement MOSFET, and biasing discrete and integrated MOS amplifier circuits, single-stage MOS amplifiers, MOSFET as a switch, CMOS inverter.
Operational amplifiers (Op-Amp): Properties of ideal Op-Amps, non-inverting and inverting amplifiers, inverting integrators, differentiator, weighted summer and other applications of Op-Amp circuits.
Introduction to photodiode, Laser, Solar cell, Photo detector, LED.
.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the basis operation of diode, and diode circuits
CLO 2	Identify different MOSFET circuits
CLO 3	Differentiate between switching network of BJT and MOSFETs
CLO 4	Design BJT amplifier circuits and perform DC and AC analysis.

CLO 5	Design JFET amplifier circuits and perform DC and AC analysis.
CLO 6	Interpret the basic semiconductor theory
CLO 7	Formulate an understanding for special purpose MOSFET

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1	X							
CLO 2	X	X						
CLO 3	X	X						
CLO 4	X	X						
CLO 5	X							
CLO 6					X			
CLO7	X							

Recommended Books

1. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
2. Microelectronic Circuits- Sedra/Smith
3. Digital logic and Computer Design – M. Morris Mano

Course Title: Electronic Devices and Circuits Lab	Year/Semester: 1/2	Course Status: Lab
Course Code: EEE 112D	Credits: 1.5	Contact hours: 3 hours lab per week

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-111D. Theoretical knowledge is incomplete without hands-on experiments using the basic components and measuring devices. This is an introductory experimental laboratory that explores the design, construction, and debugging of analog electronic circuits. Lectures and two laboratory projects investigate the performance characteristics of diodes, transistors, JFETs, and MOSFETS, including the construction of a small audio amplifier and preamplifier. The course provides opportunities to simulate real-world problems (as given as assignment) and solutions that involve tradeoffs and the use of engineering judgment.

Course objectives are:

- Acquaint students with the basic idea about implementing different types of diode circuits and investigates the voltage, current relationships.
- To help them develop skills for calculating voltage gain, current gain, overall gain in a multistage BJT, JFET and MOSFET amplifiers.
- To provide the students with capability of implementing different real life analog electronic circuits.

Course Contents:

- To familiarize students with electronics devices and Laboratory Equipment.
- To study of V-I Characteristics curve of P-N junction diode.
- To study of Half-Wave Rectification circuit.
- To study of Full-Wave Rectification circuit (Bridge & Center- tap).
- To study of Clipping and clamping circuit.
- To study MOSFET and BJT characteristics.
- Speech/ Audio amplification using NPN/PNP Transistor.
- MOSFET as an amplifier and switch.
- Different operational amplifier circuits.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain operation of diodes.
CLO 2	Calculate operating point and perform DC analysis.
CLO 3	Distinguish and interpret operation of BJT, JFET and MOSFET
CLO 4	Differentiate between BJT, JFET and MOSFET amplifier circuits.
CLO 5	Differentiate between BJT and MOSFET switching circuits
CLO 6	Design types of diode circuits.
CLO 7	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1				X							
CLO 2			X	X							
CLO 3			X	X							
CLO 4			X	X							
CLO 5				X							
CLO 6				X							
CLO7							X			X	X

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L.Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith

Course Title: Fundamentals of Electrical and Electronic Engineering		Year/Semester:1/2	Course Status: Theory
Course Code: EEE 111Q	Credits: 3.0	Contact hours: 3 hours lecture per week	

Rationale

This is an introductory course which gives a thorough idea on different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks including the use of phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices.

Course Objectives are:

- To facilitate necessary knowledge about electrical charge, voltage, current and power.

- To help students develop basic knowledge of DC circuit behavior.
- Help the students to conceptualize with the use of circuit analysis theorems and methods.
- To familiarize the students with the basics of AC networks.
- Acquaint students with the modeling and analysis of single phase RLC circuits for impedances, voltages, currents, powers and phase shift.
- Accumulate the basic knowledge about operations, device and circuit characteristics of diodes, BJT, JFET, MOSFET and Op-Amp.

Course Contents:

Circuit variables and elements: Voltage, current, power, energy, independent and dependent sources, and resistance.

Basic laws: Ohm's law, Kirchhoff's current and voltage laws.

Simple resistive circuits: Series and parallel circuits, voltage and current division, wye-delta transformation.

Techniques of circuit analysis: Nodal and mesh analysis including super node and super mesh.

Network theorems: Source transformation, Thevenin's, Norton's and superposition theorems with applications in circuits having independent and dependent sources, maximum power transfer condition and reciprocity theorem.

Energy storage elements: Inductors and capacitors, series parallel combination of inductors and capacitors.

Responses of RL and RC circuits: Natural and step responses.

Sinusoidal functions: Instantaneous current, voltage, power, effective current and voltage, average power, phasors and complex quantities, impedance, real and reactive power, power factor.

Analysis of single-phase AC circuits: Series and parallel RL, RC and RLC circuits, nodal and mesh analysis, application of network theorems in AC circuits.

P-N junction as a circuit element: Intrinsic and extrinsic semiconductors, operational principle of p-n junction diode, contact potential, current-voltage characteristics of a diode, Diode circuits: Half wave and full wave rectifiers, rectifiers with filter capacitor, characteristics of a Zener diode, clamping and clipping circuits.

Bipolar Junction Transistor (BJT) as a circuit element: current components, BJT characteristics and regions of operation, BJT as an amplifier, biasing the BJT for discrete circuits, small signal equivalent circuit models, BJT as a switch.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET) as circuit element: structure and physical operation of an enhancement MOSFET, threshold voltage, Body effect, current-voltage characteristics of an enhancement MOSFET, and biasing discrete and integrated MOS amplifier circuits, single-stage MOS amplifiers, MOSFET as a switch, CMOS inverter.

Operational amplifiers (Op-Amp): Properties of ideal Op-Amps, non-inverting and inverting amplifiers, inverting integrators, differentiator, weighted summer and other applications of Op-Amp circuits.

Introduction to photodiode, Laser, Solar cell, Photo detector, LED.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the Basic concepts of Electrical Circuits
CLO 2	Explain the basis operation of diode, and diode circuits
CLO 3	Interpret of AC networks and phasor
CLO 4	Apply network techniques to AC circuits and networks
CLO 5	Analyze the electrical circuits using different analysis methods and
CLO 6	Distinguish between different MOSFET circuits
CLO 7	Design and analysis BJT amplifier circuits
CLO 8	Design and analysis JFET amplifier circuits
CLO 9	Analyze RLC circuit performance by hand.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1	X									
CLO 2	X									
CLO 3	X									
CLO 4	X									
CLO 5	X	X								
CLO 6		X								
CLO 7		X						X		
CLO 8		X						X		
CLO 9		X						X		

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L.Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith

Course Title: Fundamentals of Electrical and Electronic Engineering Lab		Year/Semester:1/2	Course Status: Lab
Course Code: EEE 112Q	Credits: 1.0	Contact hours: 2 hours lab per week	

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-111Q. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits by experimentation. This course also explores the design, construction, and debugging of analog electronic circuits. It contains experiments investigating the performance characteristics of diodes, transistors, including the construction of AC circuits.

Course Objectives are

- To facilitate students with necessary knowledge of real-life dc circuits.
- Acquaint the students with the techniques of solving of different types of circuits by network theorem.
- To provide basic knowledge about voltage, current and load relationship in a network.

- To help students develop basic skills for transient analysis and steady state analysis of a capacitor and inductor network.
- To help students conceptualize about basic AC circuit and perform experiments on them.
- Accumulate basic ideas about diode, transistors, op-amps and their applications

Course Contents:

- To get familiar with the operation of different electrical instruments.
- To verify the following theorems:
- KCL and KVL theorem,
- Superposition theorem,
- Thevenin's theorem,
- Norton's theorem and
- Maximum power transfer theorem
- RL and RC response.
- Study the frequency response of an RLC circuit and find its resonant frequency.
- Basic electrical element like fan, bulb, calling bell etc. connection from 220v AC
- Single phase supply.
- To familiar with electronics devices and Laboratory Equipment.
- To study of V-I Characteristics curve of P-N junction diode.
- To study of Half-Wave Rectification circuit.
- To study of Full-Wave Rectification circuit (Bridge &Center- tap).
- To study of Clipping and clamping circuit.
- To study MosFET and BJT characteristics.
- Speech/ Audio amplification using NPN/PNP Transistor.
- MosFET as an amplifier and switch.
- Different operational amplifier circuits.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the operation of BJT , JFET and MOSFET.
CLO 2	Identify BJT, JFET and MOSFET amplifier circuits
CLO 3	Impart the idea about complex circuit network.
CLO 4	Interpret transient response about capacitor and inductor circuits.
CLO 5	Calculate of operating point and perform DC analysis on circuits.
CLO 6	Differentiate between different types of diode circuits
CLO 7	Differentiate different types of electrical instruments and measuring devices.
CLO 8	Distinguish BJT and MOSFET switching circuits
CLO 9	Design AC electrical circuits on breadboard and perform measurements with electronic test equipment
CLO 10	Design experiments to interpret different types of circuit analysis theorem and laws
CLO 11	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1						**X**				
CLO 2						**X**				
CLO 3						**X**				
CLO 4						**X**				
CLO 5						**X**				
CLO 6						**X**				
CLO 7						**X**				
CLO 8						**X**				
CLO 9								**X**	**X**	
CLO 10								**X**	**X**	
CLO 11					**X**					**X**

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L.Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith

Course Title: Basic Electrical and Electronic Circuits	Year/Semester:1/2	Course Status: Theory
Course Code: EEE 105B	Credits: 3.0	Contact hours: 3 hours lecture per week

Rationale

This is an introductory course which gives a thorough idea on different types of circuit analysis techniques to analyze simple and complex circuits. It also provides ideas about AC networks including the use of phasor and impedance diagrams. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing circuits involving transistors, diodes, operational amplifiers and basic logic gates. The course focuses on developing fundamental ideas and basic concepts on electrical equipment and electronic devices.

Course Objectives are:

- To facilitate the basic concepts of electrical charge, voltage, current and power
- To help students develop basic knowledge of DC circuit behavior.
- To acquaint students with basic theorems of circuit analysis.
- To help students conceptualize about basic AC circuit.
- Accumulate basic ideas about diode, transistors, op-amps and their applications
- To enhance students skills to analyze and design of analogue circuits such as amplifiers.
- To develop the skills to solve mathematical problems of simple and complex electrical circuits.
- To introduce the basic principle operations, device and circuit characteristics of diodes and BJT JFET and MOSFET transistors.
- To provide the basic idea about semiconductor theory
- To facilitate the basic concepts of Boolean algebra and logic gates.

Course Contents:
Voltage and Current, Power and Energy, Ohm's law, Series-Parallel circuits, Voltage division and current division, KVL, KCL, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Maximum power transfer, Source transformation, Capacitors and
Inductors with series parallel connection, Sinusoidal alternating wave forms, phasor diagram ,phase relation.
Diode construction, I-V characteristics of diode, half and full wave rectifier, series-parallel configuration of diode, Bipolar junction transistor construction, common emitter, common base, common collector configuration, operating point of BJT, Fixed bias circuit, Emitter stabilized bias circuit, Voltage divider bias.
Binary logic, Boolean algebra, De Morgan's theorem, Basic Logic gates, Universal gates.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the Basic concepts of Electrical Circuits.
CLO 2	Explain the basics of diode, transistors, op-amps and their applications.
CLO 3	Describe the idea of AC networks and phasor.
CLO 4	Describe the basic concepts of logic gates.
CLO 5	Solve and Analyze the electrical circuits using different analysis methods and theorems
CLO 6	Design combinational and sequential circuits.
CLO 7	Interpret different diode and transistor modes.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9
CLO 1						X			
CLO 2						X	X		
CLO 3						X	X		
CLO 4						X	X		
CLO 5						X			
CLO 6						X			
CLO 7						X			

Recommended Books
1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylestad
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith
5. Digital logic and Computer Design – M. Morris Mano

Course Title: Basic Electrical and Electronic Circuits Lab	Year/Semester: 1/2	Course Status: Lab
Course Code: EEE 106B	Credits: 1.5	Contact hours: 3 hours lab per week

Rationale
In this course students will perform experiments to verify practically the theories and concepts learned in EEE-105B. Theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in electrical circuits' analysis. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits. It contains experiments of investigating the performance characteristics of diodes and different types of diode circuits. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean algebra, Logic Circuits, and Logic Minimization Techniques.

Course Objectives are
- To provide the students with capability of implementing different real-life dc circuits.
- To provide the students with the techniques of solving of different types of circuits by network theorem.
- To assist students develop basic knowledge about voltage, current and load relationship in a network.
- To teach the basics of diode, transistors, op-amps and their applications
- To assist students develop basic knowledge about the basics of Boolean algebra and logic gates.

Course Contents:
- Use of measuring Equipment: Multi-meter, Frequency meter and Oscilloscope
- Test of Ohm's Law plot of I-V, P-V curve
- Verification of KVL
- Verification of KCL
- Determination of Thevenin's equivalent circuit
- Verification of superposition theorem
- Making AND/OR gates using diode/ transistors
- Making half wave and full wave rectifier
- To construct and study the following logic gates: AND, OR, NOT. NAND, NOR, EXOR
- Verify the DE Morgan's Law: Law(I) and Law (II)
- To Verify different kind of applications of Boolean algebra.

Course Learning Outcomes:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic operation of different types of electrical instruments and measuring devices.
CLO 2	Describe the characteristics of diode.
CLO 3	Use network theorems and laws for different type of circuit analysis.
CLO 4	Construct different rectifier circuits.
CLO 5	Manipulate logic expressions using binary Boolean algebra.
CLO 6	Design combinational and sequential circuits.
CLO 7	Demonstrate team-based communication skills, magnify their moral

	standards and apply these in practical life.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9
CLO 1							X		
CLO 2							X		
CLO 3							X		
CLO 4							X		
CLO 5							X		
CLO 6							X		
CLO 7								X	X

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L.Boylestad

- Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
- Microelectronic Circuits- Sedra/Smith
- Digital logic and Computer Design – M. Morris Mano

Course Title: Building Service Design		Year/Semester: 1/2	Course Status: Lab
Course Code: EEE 128C	Credits: 1.5	Contact hours: 3 hours Lab per week	

Rationale:

Electrical services are a vital component in any building, so it is necessary for civil engineers to understand the basic principle of services design. This Course content includes the concepts of wiring system design, various lighting schemes, design of substation layout of equipment and design of security systems. This course will help students of architecture to trouble shoot a design problem on a single/multi-storied building/structure.

Course objectives are:

- To train and equip civil engineers with appropriate knowledge and skills required for the lighting design, power supply design and their installations.
- To familiarize the students with electrical design process.
- To provide enough knowledge to the students of architecture so that they can interpret various components of the service design of the building.

Course Contents:

- Electrical units and standards, Ohm's law, KVL and KCL, Basics of AC circuits.
- Wiring system design, Fitting and Fixture layout, Conduit layout, drafting, and estimation.
- Design for illumination and lighting.
- Electrical installations system design: substation, BBT and protection, heating and lifts.
- Design for intercom, public address systems, telephone system and LAN.
- Design of security systems including CCTV, fire alarm, smoke detector, burglar alarm, and sprinkler system.
- A design problem on a single/multi-storied building/structure.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Describe the basic concepts of lighting design, power supply distribution design and installations.
CLO 2	Explain advantage of Security & Protection System.
CLO 3	Interpret various symbols used in the electrical plan of a building.
CLO 4	Design the infrastructure according to the power and load demand of the client.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11	PLO 12
CLO 1		X				X						
CLO 2	X				X							
CLO 3	X				X	X						
CLO 4	X	X				X				X		X

Recommended Books

1. Electrical Wiring Estimating and Costing by S.L. Uppal and G.C. Garg

Course Title: Introduction to Electrical and Electronic Circuits		Year/Semester: 2/1	Course Status: Theory
Course Code: EEE 103G	Credits: 2	Contact hours: 2 hours lecture per week	

Rationale

This is an introductory course in Electrical and Electronic Engineering, introducing simple eleical DC circuits as well as the technical skills to facilitate necessary knowledge to analyze
such simple and complex circuits. It is a course suitable for students pursuing further studies in electrical, electronic or telecommunications engineering as well as some other related engineering disciplines. It gives the through idea about different types of circuit analysis techniques. This course endeavors to build on this knowledge and further expand student's skill in analyzing and designing analogue circuits involving diodes. It covers the basic principles of operation and device characteristics of diodes. It also includes study of basic logic gates which will help the students to understand and build logic devices.

Course Objectives are

- To facilitate the basic concepts of electrical charge, voltage, current and power
- To help students develop basic knowledge of DC circuit behavior.
- To acquaint students with basic theorems of circuit analysis.

- Accumulate basic ideas about diode and its applications
- To develop the skills to solve mathematical problems of simple and complex electrical circuits.
- To facilitate the basic concepts of Boolean algebra and logic gates.

Course Contents:

Voltage and Current, Power and Energy, Ohm's law, Series-Parallel circuits, Voltage division and current division, KVL, KCL, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin's theorem, Source transformation, Capacitors and Inductors with series parallel connection.

Diode, I-V characteristics of diode, half and full wave rectifier, series- parallel configuration of diode.

Binary logic, Boolean algebra, De Morgan's theorem, Basic Logic gates, Universal gates.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic concepts of Electrical Circuits.
CLO 2	Describe the basics of diode and its applications
CLO 3	Explain the basic concepts of logic gates.
CLO 4	Solve and analyze the electrical circuits using different analysis methods and theorems
CLO 5	Interpret logical circuits and manipulate them.
CLO 6	Design basic circuits with diodes.
CLO 7	Formulate logical circuits from logical expressions.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11
CLO 1	X										
CLO 2	X	X									
CLO 3	X	X									
CLO 4	X	X									
CLO 5	X										
CLO 6	X										
CLO 7	X										

Recommended Books

- Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
- Introductory Circuit Analysis by Robert L. Boylestad
- Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
- Microelectronic Circuits- Sedra/Smith
- Digital logic and Computer Design – M. Morris Mano

Course Title: Introduction to Electrical and Electronic Circuits Lab	Year/Semester: 2/1	Course Status: Lab
Course Code: EEE 104G	Credits: 1.5	Contact hours: 3 hours lab per week

Rationale

In this course students will perform experiments to verify practically the theories and concepts learned in EEE-103G. Theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in electrical circuits' analysis. This course teaches the fundamentals of electrical circuits, application of circuit laws, theorems and measuring techniques for DC circuits. It contains experiments of investigating the performance characteristics of diodes and different types diode circuits. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean Algebra, Logic Circuits, Logic Minimization Technique

Course Objectives are:

- Acquaint the students with different real-life dc circuits.
- To develop the students skills to solve of different types of circuits by network theorem.
- To provide basic knowledge about voltage, current and load relationship in a network.
- To help students conceptualize about basic AC circuit.
- Accumulate basic ideas about diode and its applications
- To facilitate the basic concepts of Boolean algebra and logic gates.

Course Contents:

- Use of measuring Equipment: Multi-meter, Frequency meter and Oscilloscope.
- Test of Ohm's Law plot of I-V, P-V curve.
- Verification of KVL.
- Verification of KCL.
- Determination of Thevenin's equivalent circuit.
- Verification of superposition theorem.
- Making AND/OR gates using diode/ transistors.
- Making half wave and full wave rectifier.

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain the basic operation of different types of electrical instruments and measuring devices.
CLO 2	Describe the characteristics of diode.
CLO 3	Use network theorems and laws for different type of circuit analysis
CLO 4	Construct different rectifier circuits.
CLO 5	Manipulate logic expressions using binary Boolean algebra.
CLO 6	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO/ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10	PLO 11

CLO 1					X						
CLO 2			X		X						
CLO 3			X		X						
CLO 4			X		X						
CLO 5	X				X						
CLO 6	X				X						

Recommended Books

1. Fundamental of Electric Circuits – Charles K. Alexander and Matthew N.O. Sadiku
2. Introductory Circuit Analysis by Robert L. Boylesta
3. Electronic Devices and Circuit Theory by Robert L. Boylestad and Louis Nashlesky
4. Microelectronic Circuits- Sedra/Smith
5. Digital logic and Computer Design – M. Morris Mano

Course Title: Digital Logic Design		Year/Semester: 2/2	Course Status: Theory
Course Code: EEE 201D	Credits: 3.0	Contact hours: 3 hours lecture per week	

Rationale

The main aim of this course is to provide practical knowledge of the principles and practices of digital systems, both at the device and circuit level. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean Algebra,Logic Circuits, Logic Minimization Techniques, Multiplexers, Adders, Flip-Flops, Counters, Registers, State Machines, Memory Circuits, Digital / Analog Conversion, Programmable Logic Circuits and Microcomputer Bus Architecture. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment.

Course Objectives are:

- To make students understand the fundamental principles in design and implementation of digital logic circuits including combinational circuits, sequential circuits, and finite state machines.
- To develop skills to perform decimal, octal, hexadecimal, and binary conversions.
- To provide the knowledge to apply Boolean algebra to solve logic functions.
- To help students in learning the analysis of pulse circuits.
- To develop skills for multiplexing digital circuits.
- Help students conceptualize with the basics of logic family.
- Make the students devise logic switching circuits.
- Accumulate the basic idea of memory storage devices.
- To acquaint students with the basic tools to plan and execute projects in digital circuits
- Foster the analytical and critical knowledge to develop logic design circuits with Programmable Logic Devices

Course Contents:

Logic Families: TTL, CMOS, ECL, Tristate
Logic Gates: AND, OR, NAND, NOR, X-OR, X-NOR, Circuit Design
Flip flops: SR, JK, D, Master Slave, Application, and Synchronization
Logic Circuits: Coder, Decoder, Mux, Dmux
Counters: Synchronous, Asynchronous, Up/Down, Ripple, Cascading
Registers: Shift registers
Memory Devices: ROM, RAM, Static, Dynamic, Memory Operation
Arithmetic Circuits: Adder, Carry, Look Ahead, ALU
PAL: Micro-program Control, FPGA, HDLA

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Explain binary, octal, hexadecimal, BCD number systems
CLO 2	Reproduce logic expressions using binary Boolean algebra
CLO 3	Generate the prime implicates of logic functions of 5 or fewer variables using graphical (Karnaugh map) method, and to obtain their minimal two-level implementations with and without don't cares.
CLO 4	Analyze combinational circuits
CLO 5	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 6	Manipulate synchronous sequential circuits to extract next state/output functions
CLO 7	Translate a word statement specifying the desired behavior of a simple sequential system into a finite state machine (FSM), to simplify and build the architecture that consists of state register and next state/output logic
CLO 8	Apply simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO\CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1					X			
CLO 2					X			
CLO 3					X			
CLO 4					X			
CLO 5					X			
CLO 6				X	X			
CLO 7				X	X			
CLO 8				X	X			

Recommended Books

1. Digital Logic Design by Morris Mano
2. Digital Systems by Ronald Tocci, Neal Widmer, Greg Moss
3. Digital Principles and Applications by Donald P Lech, Albert Paul Malvino and Goutam Saha

Course Title: Digital Logic Design Lab		Year/Semester: 2/2	Course Status: Lab
Course Code: EEE 202D	Credits: 1.5	Contact hours: 3 hours lab per week	

Rationale

The main aim of this course is to provide practical knowledge of the principles and practices of digital systems, both at the device and circuit level. The course covers practical experiments of the topics of digital electronics including: Number Theory, Boolean Algebra, Logic Circuits, Logic Minimization Techniques, Multiplexers, Adders, Flip-Flops, Counters, Registers, State Machines, Memory Circuits, Digital / Analog Conversion, Programmable Logic Circuits and Microcomputer Bus Architecture. Upon completion, students should be able to construct, analyze, verify, and troubleshoot digital circuits using appropriate techniques and test equipment.

Course Objectives are

- To help students to conceptualize the fundamental principles in design and implementation of digital logic circuits including combinational circuits, sequential circuits, and finite state machines.
- To develop skills to perform decimal, octal, hexadecimal, and binary conversions.
- To provide the knowledge to apply Boolean algebra to solve logic functions.
- To help students in learning the analysis of pulse circuits.
- To develop skills for multiplexing digital circuits.
- Help students conceptualize with the basics of logic family.
- Make the students devise logic switching circuits.
- Accumulate the basic idea of memory storage devices.
- To acquaint students with the basic tools to plan and execute projects in digital circuits.
- To foster the analytical and critical knowledge to develop logic design circuits with Programmable Logic Devices.

Course Contents:

- Logic circuits using combination of gates
- To construct and study the following logic gates: AND, OR, NOT. NAND, NOR, EXOR
- Verify the DE Morgan's Law: Law(I) and Law (II)
- To verify different kind of applications of Boolean algebra.
- To construct an AND gate by diode resistors and observe its characteristics.
- To verify the characteristics of Exclusive OR and Exclusive NOR using basic logic gate.
- Verification of De-Morgan's Theorem for 2 input Variable.
- To simplify the given Boolean function by using K-map and implement it with logic Diagram.
- ABCD to 7 Segment Decoder
- Study of 4-bit BCD adder.
- Study of Asynchronous & Synchronous R-S Flip-Flop.
- Study of J-K Flip-Flop.
- Study of 4-bit binary Ripple Counter.
- Verilog HDL Basics.
- Project with PAL/FPGA/Microcontroller

Course Learning Outcomes:

After the successful completion of the course, the student will be able to-

CLO 1	Understand and analyze combinational circuits
CLO 2	Generate the prime implicates of logic functions of 5 or fewer variables using graphical (Karnaugh map) method efficiency, and to obtain their minimal two-level implementations with and without don't cares.
CLO 3	Manipulate logic expressions using binary Boolean algebra
CLO 4	Use basic functional & timing (clocking) properties of latches & flip-flops.
CLO 5	Analyze synchronous sequential circuits to extract next state/output functions
CLO 6	Translate a word statement specifying the desired behavior of a simple sequential system into a finite state machine (FSM), to simplify and build the architecture that consists of state register and next state/output logic
CLO 7	Design simple digital systems using controller and basic data path components such as registers, memories, counters, multiplexers, ALUs, etc.
CLO 8	Demonstrate team-based communication skills, magnify their moral standards and apply these in practical life

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8
CLO 1			X					
CLO 2			X					
CLO 3			X					
CLO 4			X					
CLO 5			X					
CLO 6				X				
CLO 7				X	X			
CLO 8						X		

Recommended Books

1. Digital Logic Design by Morris Mano
2. Digital Systems by Ronald Tocci, Neal Widmer, Greg Moss
3. Digital Principles and Applications by Donald P Lech, Albert Paul Malvino and Goutam Saha

Course Title: Fundamentals of Electrical Machines		Year/Semester: 2/1	Course Status: Theory
Course Code: EEE 213Q	Credit: 3.0	Contact hours: 3 hours Lecture per week	
Pre-requisite: EEE 111 (Fundamentals of Electrical and Electronic Engineering)			

Rationale:

Electrical engineering includes study of large number of electrical machines which are used every day. These machines are found in regular wrist watches as well as large industries. The wide usage of these machines compels every engineer to know and understand their basic functions. So, students should have insight knowledge of how electric machineries works and how to handle them. This course examines the

basic theory, characteristics, construction, operation and application of rotating electrical machines. It includes the study of transformer, poly-phase induction motors, synchronous generator, synchronous motor and DC machines.

Course objectives are:

- To teach the construction, characteristics, operation and application of both DC and AC machines including of transformer, poly-phase induction motors, synchronous generator, synchronous motor and DC machines.
- To help the students develop skills to solve problems relating to generated voltage, terminal voltage, currents, load power factors, input and output power, efficiency, and voltage regulation in transformers.
- To help the students develop skills to solve problems relating to synchronous speed, slip, rotor frequency, rotor voltage, rotor current, torque, developed power, efficiency and power factor in poly-phase induction motors.
- Facilitate necessary knowledge to explain the results of laboratory tests on various rotating and static electrical machines under load conditions.
- Helping the students to develop ability to safely wire and operate electrical rotating machines and their associated metering and starting equipment.
- To teach the construction, characteristics, operation and application of both DC and AC machines including dc motor, dc generator, alternator and synchronous motor.
- To help the students develop skills to solve problems relating to generated voltage, terminal voltage, currents, torque, speed, input and output power, efficiency, and voltage/speed regulation in DC generators.
- To help the students develop skills to solve problems relating to rotor speed, flux, torque, developed power, efficiency in DC motors.
- To help the students develop skills to solve problems relating to generated voltage, terminal voltage, current, frequency, load power factors, and synchronous impedance in poly-phase alternators.
- Helping the students to develop ability to safely wire and operate electrical rotating machines and their associated metering and starting equipment.
- To describe the design of major classes of electric machines.

Course Contents:

Transformer: Ideal transformer- transformation ratio, no-load and load vector diagrams; actual transformer- equivalent circuit, regulation, short circuit and open circuit tests. **Three phase induction motor:** Rotating magnetic field, equivalent circuit, vector diagram, torque-speed characteristics, effect of changing rotor resistance and reactance on torque-speed curves, motor torque and developed rotor power, no-load test, blocked rotor test, starting and braking and speed control. **Single phase induction motor:** Theory of operation, equivalent circuit and starting. **Synchronous Generator:** excitation systems, equivalent circuit, vector diagrams at different loads, factors affecting voltage regulation, synchronous impedance, synchronous impedance method of predicting voltage regulation and its limitations. **Parallel operation:** Necessary conditions, synchronizing, circulating current and vector diagram. **Synchronous motor:** Operation, effect of loading under different excitation condition, effect of changing excitation, V-curves and starting. **DC generator:** Types, no-load voltage characteristics, build-up of a self-excited shunt generator, critical field resistance, load-voltage characteristic, effect of speed on no-load and load characteristics and voltage regulation. **DC motor:** Torque, counter emf, speed, torque-speed characteristics, starting and speed regulation. Introduction to wind turbine generators.

Course Learning Outcome:

After the successful completion of the course, the student will be able to-0

CLO 1	Explain Transformer operating principle.
CLO 2	Identify the inadequacies of Transformers and how to reduce them.
CLO 3	Understand three phase power generation and distribution system.
CLO 4	Explain induction motor design and working principle.
CLO 5	Understand the three-phase synchronous generator operating principle.
CLO 6	Understand DC machine design and working principle.
CLO 7	Apply measures for efficient operation of electrical machines
CLO 8	Calculate Transformer, induction motor parameters and DC machine parameters theoretically and practically.
CLO 9	Interpret synchronous generators voltage regulation on different loads
CLO 10	Differentiate between AC and DC machines.
CLO 11	Design systems with parallelly connected generators.
CLO 12	Evaluate which machine is effective in different conditions.
CLO 13	Formulate proper procedure for speed control, starting and braking.

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO 1	PLO2	PLO3	PLO4	PLO 5	PLO6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1									X	
CLO 2	X									
CLO 3	X									
CLO 4	X									
CLO 5	X									
CLO 6	X									
CLO 7	X									
CLO 8								X		
CLO 9	X									
CLO 10										
CLO 11									X	
CLO 12								X	X	
CLO 13								X		

Recommended Books:

1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta

Course Title: Electrical Machines Sessional	Year/Semester: 2/1	Course Status: Lab

Course Code: EEE214Q	Credit: 1.0	Contact hours: 2 hours of Lab per week
Pre-requisite: EEE 112 (Fundamentals of Electrical and Electronic Engineering Lab)		

Rationale:
Electrical engineering is a field of engineering that generally deals with the study and application of electricity, electronics, and electromagnetism. Generation of electricity includes electric machineries. So student should have insight knowledge of how electric machineries works and how to handle them. The theoretical knowledge is incomplete without hands on experiments using the basic components and measuring devices used in Energy Conversion. This course is designed to complement the theoretical course EEE 213.

Pre-requisite: EEE 112 Fundamentals of Electrical and Electronic Engineering Lab.
Course objectives are:

- To facilitate necessary knowledge about different DC and AC machines and handle various lab apparatus.
- To determine voltage transformation ratio and turn ratio of transformer and experience their importance.
- Helping the students to develop ability in examining the effect of resistive, inductive and capacitive loading of single phase transformer.
- To describe to determine different transformer parameters without actually loading the transformer.
- To describe to determine different AC asynchronous motor parameters without actually loading the motor.
- To help students develop skills to control the speed of dc motor and observe the existence of back EMF.
- To describe the importance of residual magnetism on voltage build-up of dc generator.
- To help students determine voltage regulation of dc generator.
- To provide basic knowledge to obtain O.C.C and loading curve of synchronous generator.
- To provide basic knowledge to obtain V-curve of synchronous motor.

Course Contents:

1. Familiarization with the lab, its equipment and laboratory regulation.
2. Determination of voltage transformation ratio and turn ratio of a single phase transformer.
3. Determination of regulation and efficiency with resistive, inductive and capacitive loading of a single phase and three phase transformer.
4. Short circuit and open circuit of single phase transformer.
5. No load test and blocked rotor test of three phase induction motor.
6. Three phase induction motor speed control and drawing torque-speed curve.
7. Single phase capacitor-run induction motor speed control.
8. Determining torque-speed characteristics of DC motor.
9. Determining voltage regulation of DC shunt generator.
10. No load and loading characteristics of synchronous generator.
11. Determining V-curve of synchronous motor.

Course Learning Outcome:
After the successful completion of the course, the student will be able to-

CLO 1	Explain the safety procedures for high voltage electrical machines.
CLO 2	Identify and interpret different electrical machines.
CLO 3	Calculate transformer and induction motor parameters practically.
CLO 4	Draw equivalent circuit of transformers and induction motors from experiments.
CLO 5	Apply induction motor speed control techniques.
CLO 6	Calculate synchronous generators voltage regulation on different loads.
CLO 7	Calculate DC machine parameters theoretically and practically.
CLO 8	Calculate electrical system's efficiency and improve it.
CLO 9	Interpret torque-speed characteristics of different machines.
CLO 10	Differentiate between synchronous motor and machine V-curve.
CLO 11	Differentiate between AC and DC machines

Mapping of Course Learning Outcomes to Program Learning Outcomes:

PLO/ CLO	PLO1	PLO2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9	PLO 10
CLO 1					X					
CLO 2					X					
CLO 3					X					
CLO 4					X					
CLO 5								X		
CLO 6					X					
CLO 7					X					
CLO 8					X				X	
CLO 9								X		
CLO 10					X					
CLO 11					X					

Recommended Books:

1. A Textbook of Electrical Technology (Volume II) by B.L. Theraja and A.K. Theraja
2. Electric Machines by Charles I. Hubert
3. Principles of Electrical Machines by V.K. Mehta and Rohit Mehta

Course Title: Building Services III	Year/Semester: 3/2	Course Status: Theory
Course Code: EEE 305A	Credits: 2.0	Contact hours: 2 hours Lecture per week

Rationale:
Electrical services are a vital component in any building, so it is necessary for architects to understand the basic principle of services design. This Course content includes the concepts of
wiring system design, various lighting schemes, design of substation layout of equipment and design of security systems. This course will help students of architecture to trouble shoot a design problem on a single/multi-storied building/structure.

Course Objectives

1. To train and equip architects with appropriate knowledge and skills required for the lighting design, power supply design and their installations.
2. To familiarize the students with electrical design process.
3. Provide enough knowledge to the students of architecture so that they can interpret various components of the service design of the building.

Course Contents:

- Electrical units and standards, Ohm's law, KVL and KCL, Basics of AC circuits.
- Wiring system design, Fitting and Fixture layout, Conduit layout, drafting, and estimation.
- Design for illumination and lighting.
- Electrical installations system design: substation, BBT and protection, heating and lifts.
- Design for intercom, public address systems, telephone system and LAN.
- Design of security systems including CCTV, fire alarm, smoke detector, burglar alarm, and sprinkler system.
- A design problem on a single/multi-storied building/structure.

Course Learning Outcomes:

At the end of the course, the student will be able to-

CLO 1	Understand the basic concept of lighting design, power supply distribution design and installations.
CLO 2	Explain advantage of Security & Protection System.
CLO 3	Recognize various symbols used in the electrical plan of a building.
CLO 4	Design the infrastructure according to the power and load demand of the
CLO 5	Plan for the future electrical loading needs.
CLO 6	Construct an efficient design for a particular structure design.
CLO 7	Predict annual cost of electricity according to consumption and formulate effective way to reduce it.

Mapping of Course Learning Outcomes to Program Learning Outcomes

PLO\ CLO	PLO 1	PLO 2	PLO 3	PLO 4	PLO 5	PLO 6	PLO 7	PLO 8	PLO 9
CLO 1				X		X	X	X	
CLO 2						X			
CLO 3				X		X			
CLO 4				X					
CLO 5						X	X	X	
CLO 6				X			X		
CLO 7						X		X	

Recommended Books

a. Electrical Wiring Estimating and Costing by S.L. Uppal and G.C. Garg

List of Non-Major Courses
(Offered for other departments) by Dept. of EEE

Course No.	Credit	Dept	Yr-Sem	Course Title
EEE 101W	3.0	**SWE**	1-1	Basic Electrical and Electronic Circuits
EEE 102W	1.5	**SWE**	1-1	Basic Electrical and Electronic Circuits Lab
EEE 103G	2.0	**IPE**	2-1	Introduction to Electrical and Electronic Circuits
EEE 104G	1.5	**IPE**	2-1	Introduction to Electrical and Electronic Circuits Lab
EEE 105B	3.0	**CEP**	1-2	Basic Electrical and Electronic Circuits
EEE 106B	1.5	**CEP**	1-2	Basic Electrical and Electronic Circuits Lab
EEE 105F	3.0	**FET**	1-1	Basic Electrical and Electronic Circuits
EEE 106F	1.5	**FET**	1-1	Basic Electrical and Electronic Circuits Lab
EEE 305A	2.0	**ARC**	3-2	Building Services III
EEE 128 C	1.5	**CEE**	1-2	Building Service Design
EEE 109 D	3.0	**CSE**	1-1	Electrical Circuits
EEE 110 D	1.5	**CSE**	1-1	Electrical Circuits Lab
EEE 111 D	3.0	**CSE**	1-2	Electronic Devices and Circuits
EEE 112 D	1.5	**CSE**	1-2	Electronic Devices and Circuits Lab
EEE 201 D	3.0	**CSE**	2-2	Digital Logic Design
EEE 202 D	1.5	**CSE**	2-2	Digital logic Design Lab
EEE 111Q	3.0	**MEE**	1-2	Fundamentals of Electrical and Electronic Engineering
EEE 112Q	1.0	**MEE**	1-2	Fundamentals of Electrical and Electronic Engineering Lab
EEE 213Q	3.0	**MEE**	2-1	Fundamentals of Electrical Machines
EEE 214Q	1.0	**MEE**	2-1	Electrical Machines Sessional

Ordinance for the Graduate Program at SUST

Formation of Graduate Study Committee (GSC) will be the prerequisite to start a Graduate program in any Discipline. The GSC will be headed by the Head of the Discipline/ Institute consisting of all professors/Associate Professors of the discipline concerned with a minimum number of 3 professors/Associate Professors. When Professors and Associate Professors are not available in the discipline, the required number of Professors, Associate Professors will be included from the relevant Discipline/Institute by the proposal of the Board of Advanced Studies (BAS) & the Academic council.

1. Introduction

1.1 The graduate program consists of Masters (General), Masters (Thesis), M.Sc. (Engineering), Masters of Philosophy (M.Phil.) and Ph.D. degrees.
1.2 A graduate program may also be offered by a discipline in some specified field in collaboration with other disciplines.
1.3 Any student with (i) 4 year Bachelors degree (ii) 3-year Bachelor and 1-year Masters Degree or (iii) 5-year Bachelor of Architecture degree from a recognized university is eligible to get admitted into the graduate program at SUST.
1.4 Notification for the admission process will be published every year.
1.5 After admission every student will be assigned to a student advisor/supervisor from among the teachers of his/her discipline to guide him/her throughout the academic program.

2. Qualification

2.1 Masters and M.Phil.
2.1.1 Any student with a Bachelors degree from SUST is eligible for admission to the Masters (General) Program.
2.1.2 Any student with a CGPA of 3.25 or more from SUST is eligible for admission to the Masters (Thesis), M.Phil. (Engineering) or M.Phil. Program.
2.1.3 Four-year Graduates from other recognized universities and institutions with a CGPA of 3.25 or more can apply for admission to the Masters (Thesis), M.Phil. (Engineering) or M.Phil. Program. A candidate who passed under course system and seeks admission to M.Phil program has to have First class in Masters or 50% marks in Masters and at least 2nd division in all public examination.
2.1.4 Any student registered for Masters (General) or Masters (Thesis) may transfer to the M.Phil. program, offered by the relevant discipline, if he/she can maintain a CGPA of 3.25 or more during the first two semesters.
2.1.5 The GSC of a discipline will decide if a student from a related discipline will be allowed to apply to the graduate program of that discipline. In these cases if necessary the GSC may ask the candidate to take extra undergraduate/graduate courses to ensure the basic foundation.

2.2 Ph.D.
2.2.1 Candidates with Masters (Thesis), M.Phil. or M.Sc. (Engineering) Degrees are eligible for application for Ph.D. and will be selected after a written and/or viva voce examination and the proper evaluation of academic records by the GSC. A candidate who passed under course system and seeks admission to Ph.D. program has to have First class in Masters or 50% marks in Masters and at least 2nd division in all public examination.
2.2.2 A Masters (Thesis) an M.Phil. or an M.Sc. (Engineering) student may be transferred to the Ph.D. program after the completion of first two semesters with a CGPA 3.25 and the recommendation of his/her supervisor certifying satisfactory progress of research work and with the approval of the GSC and BAS.
2.2.3 The following candidates are eligible for direct admission to Ph.D. if they have a CGPA of 3.25 or more at Bachelors and Masters Level and 3.00 or equivalent in all public examinations. (i) University teachers with two years teaching experience and one publication in standard academic journals. (ii) Teachers of colleges with three years of teaching experience and one publication in a standard academic journal (iii) Researchers of recognized research organizations with three years of research experience and at least three publications in standard academic journals. (iv) Candidates with an M.Phil degree.

3. Admission

3.1 Masters and M.Phil.
3.1.1 If a SUST graduate has the required qualifications he/she can be admitted to the Masters program (General, Thesis or Engineering) as per the recommendation of the GSC.
3.1.2 The candidates for Masters (Thesis and Engineering) and M.Phil. will be selected for admission after a written and/or viva voce examination conducted by the GSC. Full time teachers of SUST are not required to sit for the admission test. GSC will then recommend the candidates for admission to the academic council through the BAS. During the process of admission each candidate shall be assigned by the appropriate GSC and approved by BAS a supervisor from among the teachers of the relevant discipline/institute not below the rank of an associate professor or an assistant professor with a Ph.D. / M.Phil. / M.S.

3.2 Ph.D.
3.2.1 A candidate for admission to the Ph.D. degree program will apply in the prescribed form to the head of the discipline or the director of institute along with the recommendation from possible supervisor(s). The supervisor must be of the rank of professor or associate professor.
3.2.2 After approval from the GSC, the application will be forwarded to the BAS for the approvals of the supervisor and co-supervisors (if any). Each candidate shall have not more than two co-supervisors; one co-supervisor may be from outside SUST. After careful scrutiny of the research proposal BAS will send it to the Academic Council for final Approval.
3.2.3 If necessary a change of supervisor must also be approved by the BAS and the Academic Council.

4. Registration

4.1 Every selected candidate will be registered with the University and enrolled as a full time or if allowed, part time student with payment of prescribed fees and dues before the commencement of each semester.
4.2 A student has to register for at least 50% or maximum 150% credits of the courses at every semester in the prescribed syllabus. But for attaining degree in the last semester above mentioned restrictions will not be followed.

4.3 A candidate may be admitted or change his status into part time student with prior approval of the university and a written consent from the serving organization. A part time student may be assigned a minimum of 6 credit hours per semester.
4.4 A full time student must register for a minimum of 1(2.0 Credits) hours per semester. A full time student shall not be allowed to be employed as a part time employee in other organizations. However he/she may be employed as teaching/research assistant at the University. A Ph.D. candidate shall have to be a full time student for at least one year during his/her Ph.D. work.
4.5 The registration for the Ph.D. degree will remain valid for a period of four years, and can be renewed for a further period of two years.

5. Academic Regulations

5.1 Duration

5.1.1 The minimum duration for the Masters, M.Sc. (Engineering), M.Phil. and Ph.D. degrees will be as followed:

Degree	Duration of Completion	Required Credits
Masters (General)	2 Semesters	Minimum 24
Masters (Thesis)	3 Semesters	36
M.Phil. / M.Sc. (Engg.)	4 Semesters	48
Ph.D.	6 semesters	72

5.1.2 Minimum duration of M.Phil will be 4 Semesters for students who completed 3 years Bachelors and 1 year Masters degree. Minimum duration of M.Phil will be 2 semesters for students who completed 4 years Bachelors and 1 year Masters degree.

5.2 Credit Requirement

5.2.1 For the graduate program a full time student has to register for at least 1(2.0 Credits) each semester. For course work 1 credit means one hour of contact hour per week and for research or project work 1 credit hour means at least three hours per week. A student will be allowed to take theoretical course and research work simultaneously. Once the course requirement is completed, for the research work a graduate student has to register for "independent study" as credit/no-credit basis to fulfill the 1(2.0 Credits) per semester requirement.

5.3 Course Requirement

5.3.1 Syllabus committee for the graduate program will be comprised of the GSC members and two external members from other universities nominated by the Dean.
5.3.2 Every year the syllabus committee will design the graduate level courses for the respective disciplines and recommend the courses for approval of the Academic Council through the School and BAS. GSC can review the curriculum from time to time and recommend any change to the syllabus committee as may be considered necessary.

Masters and M.Phil.
5.3.3 Every Masters (general, thesis and engineering) and M.Phil. student has to complete at least 16 hours of theory course work during the first two semesters. GSC will propose the required courses to the students with consultation of respective supervisors. The course work for M.Phil Program may be reduced and relaxed according to the recommendation of GSC. In that case the duration may be reduced up to 1 year.

Ph.D.
5.3.4 The GSC may suggest courses, if felt necessary, for the Ph.D. students.

5.4 Research Work Requirement

5.4.1 Research work for thesis shall be carried out under the supervision of the supervisor. Co-supervisors from within or outside the discipline / Institute may be appointed, if necessary. The topic of research proposal shall be approved by the BAS after the completion of the required course credits within six months/one year for M.Phil. / Ph.D. on the recommendation of the Head of the Discipline/Institute. A Ph.D. student must submit a progress report of his work to the supervisor(s) at the end of the every semester who will present it to BAS.
5.4.2 The Ph.D. student will give at least one public seminar talk conducted by GSC at the Discipline / Institute every year on a topic of his own field of research.
5.4.3 The research work must be carried out in this University or at a place approved by the supervisor in consultation with the GSC.

6. Conduct of Examinations

6.1 Course Examination

6.1.1 The examination committee will conduct the course examinations as per the examination ordinance of graduate program.

6.2 Thesis Submission

6.2.1 The title of the thesis has to be approved by the BAS on the recommendation of the Head of the Discipline / Institute. For Masters/M.Phil. it has to be done at least three months and for Ph.D. it has to be done at least six months before submitting.
6.2.2 Every student shall submit to the supervisor required number of type written copies of his thesis in the approved forMATon or before a date to be fixed by the Head of the Discipline/ Institute in the consultation with the supervisor concerned.
6.2.3 The student shall declare that the research work was done by him/her and has not submitted elsewhere for other purpose (except for publication).
6.2.4 The thesis should demonstrate an evidence of satisfactory knowledge in the field of research undertaken by the student.

6.3 Masters Thesis Examination

6.3.1 There is no thesis requirement for Masters (General). The project (if any) and the thesis for Masters (Thesis) and will be evaluated as per the examination ordinance of graduate program.

6.4 M.Phil. / M.Sc. (Engineering) Thesis Examination

Thesis Evaluation
6.4.1 The academic council will, on the basis of the suggestion of the GSC and recommendation of the BAS, appoint for every thesis an examination committee consisting of two examiners of whom at least one shall be from outside this University.

6.4.2 The examiners of thesis will either accept it or reject it for the degree and then individually and separately submit one copy of their reports in sealed covers to the controller of examination and another copy to the GSC Chairman. The majority decision will be considered as the final result.
6.4.3 If a thesis is adjudged inadequate for the award of the degree, the candidate will be allowed to resubmit his thesis within six months. If the candidate fails to resubmit or the thesis is adjudged inadequate again the examiners may recommend Masters (general) degree and the controller of examination will place such recommendation before the BAS for the approval of academic council.

Oral Examination and Open Presentation
6.4.4 The GSC in consultation with the supervisor shall suggest, to the Vice Chancellor through BAS, a committee of three members for oral examination consisting of: (i) Convener: Thesis supervisor (ii) A Professor in relevant field from outside the University (iii) One of the thesis examiners.
6.4.5 If any examiner is unable to accept the appointment or has to relinquish his appointment before/ during the examination, the Vice-Chancellor shall appoint another examiner in his place as per the recommendation of GSC.
6.4.6 After the oral examination the convener will send a consolidated report to the controller of examinations stating clearly whether the award of the degree is recommended, who will in turn place it to BAS for the approval of the Academic Council.
6.4.7 In case a candidate performs unsatisfactorily in oral examination even though the thesis is adjudged adequate the examiners may recommend to the Academic Council that the candidate may be permitted to appear at another oral examination within six months from the first oral examination. No candidate shall be allowed to appear at the oral examination of the same thesis for more than two times.

Recommendation for Degree
6.4.8 After completion for the viva-voce examination, the convener of the viva examination committee will send a consolidated report, stating clearly whether the award of the degree is recommended, to the Controller who will in turn place it to BAS for the approval of the academic council.

6.5 Ph.D. Thesis Examination
Thesis Evaluation
6.5.1 The academic council will, on the basis of the suggestion of the GSC and recommendation of the BAS, appoint for every thesis an examination committee consisting of three examiners of whom one shall be the supervisor and the other two from outside this University and at least one from a university from abroad
6.5.2 One of the three examiners will be appointed by the academic council as the convener of the examination committee.
6.5.3 The examiner of thesis will individually and separately submit one copy of their reports in sealed covers to the controller of examination and another copy to the convener. Every examiner will have to explicitly state whether the award of the Ph.D. degree is recommended or not. The recommendations of all the three examiners must be explicit, unambiguous and unanimous for the award of the degree.

6.5.4 If a thesis is adjudged inadequate for the award of the Ph.D. degree, the candidate will be allowed to resubmit his thesis after six months with proper modification. If the candidate fails to resubmit or the thesis is adjudged inadequate again the examiners may recommend the award of M.Phil. or M. S. degree and the controller of examination will place such recommendation before the BAS for the approval of academic council.

Oral Examination and Open Presentation
6.5.5 On receipt of the unanimous opinions of the examiners, the convener shall fix a date and a venue and suggest, to the Vice Chancellor through BAS, a committee of three members for oral examination consisting of the convener, supervisor/co-supervisor and a thesis examiner. At least one of them has to be from outside the university.
6.5.6 If any examiner is unable to accept the appointment or has to relinquish his appointment before/during the examination, the Vice-Chancellor shall appoint another examiner in his place as per the recommendation of GSC.
6.5.7 In case a candidate is unable to satisfy the viva voice Board even though the thesis is adjudged adequate the Board may recommend to the Academic Council that the candidate may be permitted to appear at another oral examination after a lapse of six months from the first oral examination. No candidate shall be allowed to appear at the oral examination of the same thesis for more than two times.

Recommendation for Degree
6.5.8 After completion of the viva voce examination, the convener will send a consolidated report to the controller of examinations stating clearly whether the award of the degree is recommended, who will in turn place it to BAS for the approval of the Academic Council.

7. Award of the Degree

7.1 Masters
7.1.1 Students will be awarded his/her degree as per the recommendation of GSC chairman after the completion of his required credits.

7.2 M.Phil. and Ph.D.
7.2.1 The vice chancellor shall place the reports of the Oral Examination committee for consideration of the academic council which shall recommend to the Syndicate for the award of the degree.
7.2.2 A hard copy of the thesis accepted by the academic council incorporating any correction and changes suggested by the examination committee shall be preserved in the central library of the university and the corresponding electronic version shall be preserved in the archive.

8. Academic Fee

8.1 To be decided by the Academic Council and the Syndicate.

Ref.: *The clause 4.2 of this Ordinance was approved in the 119th Academic Council.*

Examination Ordinance for the Graduate Program

University authorities will administer and publish the results of Masters, M.Phil. and Ph.D. degree examinations under the graduate program. The graduate program will follow the same academic calendar of the undergraduate program for course delivery, the final examination and publication of results. The graduate courses are comprised of theory and lab courses and where applicable, the thesis for the research works. The evaluation of thesis is conducted as per the Ordinance for the Graduate Program at SUST. The theory and lab courses are conducted by the examination committee.

1. Examination Committee

1.1 The GSC of the Discipline/Institute will form the examination committee as per the rules of the University.
1.2 The examination committee will propose the examination schedule, prepare question papers, help the discipline conducting the examination, prepare results and will resolve the issues that may arise concerning the examination procedure.

2. Examination Dates and Routines

2.1 The examination routines will be designed by the respective disciplines and Head of the disciplines will notify them and send copies to the other relevant disciplines and to the office of the Controller of the Examinations.

3. Theory Courses

3.1 Distribution of Marks

A student will be continuously evaluated during the semester through tests, assignments, mid-semester examinations, viva etc. conducted by the course teachers, and it will contain 30% of total marks. The rest 70% marks will come from the final written examination at the end of that semester.

3.2 Class Performance

After the end of the classes, the course teachers will make three copies of mark-sheets showing the marks from class participation and assignment and mid semester examination. He/she will display one copy in the notice board, send one sealed copy to the chairman of the examination committee and another sealed copy to the controller of examination.

3.3 Question Setting and Moderation

3.3.1 The examination Committee will appoint two question setters for each course at least four weeks before the date of commencement of the examination and inform the Controller of examination. The controller of examination will send the necessary papers to the question setters and the examiners. If a question setter or examiner declines the responsibility, he/she will return all the papers and the examination committee will suggest an alternative question setter or examiner.
3.3.2 The chairman of the examination committee will receive all the manuscript of question papers; if no manuscript is received within the specified time the committee will suggest an alternative question setter.

3.3.3 After receiving all the question papers the examination committee will moderate the question papers. Moderation will not be invalid if any member be absent during moderation. For the disciplines of the school of Applied Sciences and Technology the questions will be divided in two groups in the question paper so that two examiners can evaluate the answer script simultaneously. The examination committee will be responsible for the preparation of the necessary editing and printing of the question papers.

3.4 Final Examination

3.4.1 The controller of examination will be responsible to print the blank answer scripts, mark sheets and other relevant forms and will make necessary arrangements, so that these are available during the conduct of examination in the examination hall in due time .

3.5 Evaluation of Answer Script

3.5.1 The answer scripts from the disciplines of Applied Science and technology will be evaluated by two examiners simultaneously, of whom one should preferably the course teacher. The answer scripts from the disciplines of other school of studies will be evaluated by two examiners separately, of whom one should preferably the course teacher. The examiners will examine the scripts thoroughly, mark the scripts properly and grade legibly within the specified time. The examiners will send a sealed copy of mark-sheet to the controller of examination and one sealed copy to the chairman of the examination committee.

3.5.2 The examination committee will assign members from the committee to scrutinize the answer scripts and if any discrepancy is found the committee will make the necessary arrangements to fix the problem and inform the controller of examination.

3.5.3 If the difference between marks given by two examiners be 20% or more than 20% GSC will recommend a third examiner for approval by the V.C and marks given by 3rd examiner & the marks of the first or 2nd examiner which ever is nearest to this will be considered for the average marks .

4. Lab Courses

4.1 Every lab course will be assigned to at least two course instructors and they will grade the students through continuous evaluation.

4.2 For the projects, Masters (Thesis), Industrial assignments, monographs etc. the supervisor will give an overall assessment which will count as 30% of the total marks. Evaluation of the report by two external examiners, who is not involved in supervision/co-supervision will count as another 30% of the marks. The remaining 40% will come from the presentation and viva voce conducted by the examination committee. During viva-voce examination the supervisor or co-supervisor, if present, will not participate in marking.

5. Publication of Result

5.1 Three original tabulation sheets will be prepared by the tabulators and checked by all the members and signed by the tabulators and members of the examination committee. The tabulation sheets will contain the grade point average obtained in the specific semester. The tabulation sheets will be sent to the Controller of Examinations for his signature and approval by the Vice-Chancellor.

5.2 The Controller of Examination shall keep up to date record of all the grades obtained by the student in individual Academic Record Card. Grades shall be announced by the Controller of Examination at the end of each semester.

Grade and grade points:

5.3 The letter grade and grade point will be awarded as follows:

Numerical Grade	Letter Grade	Grade Points
80% Or above	A+	4.00
75% to less than 80%	A	3.75
70% to less than 80%	A-	3.50
65% to less than 70%	B+	3.25
60% to less than 65%	B	3.00
55% to less than 60%	B-	2.75
50% to less than 55%	C+	2.50
45% to less than 50%	C	2.25
40% to less than 45%	C-	2.00
Less than 40%	F	0.00

6. Security and Ethics

6.1 Everyone involved in the process of examination has to guard the security of the question papers, examination grades and the final results. An examinee can never try to influence the examiners and any such attempt has to be brought to the controller of examination.

6.2 A student may never be asked a question so that he is hurt because of his religious or ethnic background.

6.3 If some one involved in the examination process has the following relatives as examinee he/she should immediately inform in to the authority: (a) Husband/wife, (b) Son/Daughter, (c) Brother/Sister, (d) Brother-in-Law/ Sister-in-Law (e) Son-in-Law/ Daughter-in-Law, (f) Nephew/ Niece, (g) Uncle/ Aunt, (h) First Cousins.

Department of Electrical and Electronic Engineering
Graduate Program
Session 2018-2019

The syllabus for the Graduate Program in EEE covers the requisite courses for the following degrees:

(1) Masters (General)
(2) Masters (Thesis)

(1) Masters (General) and (2) Masters (Thesis) Programs:

Masters (General) in EEE are spreader over two semesters and Master (Thesis) in CSE are spreader over three semesters. The department will fix the courses of two semesters for Masters (General) students including labs and viva-voce considering the minimum requirement of 24 credits for the degree. For the Masters (Thesis) students, the courses of semester-I will be identical of the Masters (General) students. The graduate studies committee (GSC) will approve the courses of semester-II and the theses for semester-III considering the minimum requirement of 36 credits for the Masters (Thesis) degree.

Courses are categorized for three semesters are as follows:

Semester I

Course No	Course Title	Hours/Week Theory and Lab	Credits
EEE 5**	Option I	3.00	3.00
EEE 5**	Option II	3.00	3.00
EEE 5**	Option III	3.00	3.00
EEE 602	Independent Study I (Thesis)/ Project	9.00	3.00
	Total	**18.00**	**12.00**

Semester II

Course No	Course Title	Hours/Week Theory and Lab	Credits
EEE 5**	Option IV	3.00	3.00
EEE 5**	Option V	3.00	3.00
EEE 5**	Option VI	3.00	3.00
EEE 510	Viva Voce	0.00	2.00
EEE 604	Independent Study II (Thesis)/ Project	9.00	3.00
	Total	**18.00**	**14.0**

Semester III

Course No	Course Title	Hours/Week Theory and Lab	Credits
EEE 606	Independent Study III (Thesis)/ Project	36.00	12.00
	Total	**36.00**	**12.00**

List of Options

Option I Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 585	Solar Thermal Energy and System	3	0	3.0
EEE 598	Renewable Energy Lab	3	0	3.0
EEE 511	Quantum Mechanics-I	3	0	3.0
EEE 569	Power Semiconductor Circuits	3	0	3.0
EEE 577	Power System Stability	3	0	3.0
EEE 537	Broadband Wireless Communications	3	0	3.0
EEE 539	Antennas and Propagation	3	0	3.0

Option II Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 587	Climatology	3	0	3.0
EEE 589	Technologies and Energy Management in Buildings	3	0	3.0
EEE 525	Quantum Optics	3	0	3.0
EEE 527	Optical Integrated Circuits	3	0	3.0
EEE 551	Advanced VLSI Design	3	0	3.0
EEE 553	Testing VLSI Circuits	3	0	3.0
EEE 547	Quantum Phenomena in Nanostructures	3	0	3.0

Option III Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 565	Semiconductor Materials and Heterostructures	3	0	3.0
EEE 531	Digital Image Processing	3	0	3.0
EEE 593	Energy Economics	3	0	3.0
EEE 573	Special Machines	3	0	3.0
EEE 563	Electric and Magnetic Properties of Materials	3	0	3.0
EEE 549	VLSI Technology and Device Modeling	3	0	3.0

Option IV Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 595	Research Methodology	0	3	3.0
EEE 591	Materials and Devices for Energy	0	3	3.0

	Applications			
EEE 513	Quantum Mechanics-II	3	0	3.0
EEE 571	Design of Power Semiconductor Circuits and Drives	3	0	3.0
EEE 533	Digital Video Processing	3	0	3.0
EEE 579	Transients in Power Systems	3	0	3.0
EEE 555	Carbon Nanotechnology	3	0	3.0
EEE 557	Nano Systems	3	0	3.0
EEE 541	Microwave Theory and Techniques	3	0	3.0

Option V Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 567	Energy Conversion	3	0	3.0
EEE 515	Optical Fiber Communication	3	0	3.0
EEE 521	Optical Waveguide Theory	3	0	3.0
EEE 523	Non-linear Optics	3	0	3.0
EEE 581	Reliability of Power System	3	0	3.0
EEE 559	Thin film Growth and Deposition	3	0	3.0
EEE 561	Semiconductor Characterization Technology	3	0	3.0
EEE 543	MOS Devices	3	0	3.0
EEE 545	Compound Semiconductor Devices	3	0	3.0

Option VI Courses

Course No.	Course Title	Hours/Week		Credits
		Theory	Lab	
EEE 517	Optical Networks	3	0	3.0
EEE 519	Laser Theory	3	0	3.0
EEE 535	Digital Speech Processing	3	0	3.0
EEE 529	Advanced Digital Image Processing	3	0	3.0
EEE 575	Advanced Machines Design	3	0	3.0
EEE 583	Energy Resources & Technologies	3	0	3.0

EEE 500/550: Thesis (12.0 credits)

EEE 511: Quantum Mechanics-I (3.0 credits)

Introduction: Empirical basis, wave-particle duality, electron diffraction, notion of state vector and its probability interpretation.

Structure of Quantum Mechanics: Operators and observables, significance of eigenfunctions and eigenvalues, commutation relations, uncertainty principle, measurement in quantum theory.

Quantum Dynamics: Time-dependent Schrodinger equation, stationary states and their significance, time-independent Schrodinger equation.

One-dimensional Schrodinger Equation: Free-particle solution, wave packets, particle in a square well potential, transmission through a potential barrier, simple harmonic oscillator by wave equation and operator methods, charged particle in a uniform magnetic field, coherent states.

Spherically Symmetric Potentials: Separation of variables in spherical polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.

Textbook:
As per Course Teacher's recommendation

EEE 513: Quantum Mechanics-II(3.0 credits)

Symmetry in Quantum Mechanics: Symmetry operations and unitary transformations, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.

Angular Momentum: Rotation operators, angular momentum algebra, eigenvalues of J2 and Jz, spinors and Pauli matrices, addition of angular momenta.

Identical Particles: Indistinguishability, symmetric and antisymmetric wave functions, incorporation of spin, Slater determinants, Pauli exclusion principle.

Time-independent Approximation Methods: Non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, variational methods, WKB method, tunnelling.

Time-dependent Problems: Schrodinger and Heisenberg picture, time-dependent perturbation theory, transition probability calculations, golden rule, adiabatic approximation, sudden approximation, beta decay as an example.

Scattering Theory: Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

Textbook:
As per Course Teacher's recommendation

EEE 515: Optical Fiber Communication (3.0 credits)

Optical fibre: modes of propagation, transmission characteristics, waveguide analysis.

Optical sources: light emitting diode (LED) and semiconductor laser diode (SLD); operational principles, characteristic curves; optical transmitter design using LED/SLD.

Optical amplifiers: laser and fibre amplifier5s. Photo detectors: P-i-N and avalanche photo detectors (APDs), noise sources. Optional modulation and detection schemes.
Direct and coherent detection receivers: configuration, operation, noise sources, sensitivity calculation, performance curves. Design of analog and digital receivers.
Transmission link analysis: point-to point and point-to multi-point links, system configuration, link power budget, rise time budget, line coding schemes, transmission system limitations, design of fibre-optic systems. Optical data buses, optical networks, fibre distributed data interface (FDDI) and synchronous optical network (SONET). Optional frequency division multiplexing (OFDM) and wavelength division multiplexing (WDM) transmission systems.

Textbook:
As per Course Teacher's recommendation

EEE 517: Optical Networks (3.0 credits)
Optical networking: principles and challenges; evolution of optical networks, wavelength routed network, wavelength division multiplexing (WDM) network, sub-carrier multiplexing optical networks.
Enabling technologies: optical transmitter, optical fiber, optical receivers, optical amplifiers, optical switching elements, optical cross-connects (OXC), multiplexers/ demultiplexers, wavelength routers, optical wavelength converters, WDM network test beds. Network architecture, IP over WDM.
Broadcast optical networks: single and multiple hop networks, channel sharing and multicasting, shared channel multicasting network-GEMNET, performance evaluation for unicast and multicast traffic, experimental WDM networks.
Wavelength routed networks: virtual topology design, routing and wavelength assignment, circuit switched and packet switched approaches, performance evaluation. Reconfiguration in WDM network, network control and management, network optimization, design considerations. Multi wavelength star and ring networks. Photonic switching, optical TDM (OTDM) and optical CDMA (O-CDMA) networks, next generation optical networks.

Textbook:
As per Course Teacher's recommendation

EEE 519: Laser Theory (3.0 credits)
Black body radiation and the Planck law. Stimulated and spontaneous emission, atomic and spectral line width, 3-level atomic, systems. Laser operation under steady state condition, laser output coupling and power . Q-switching and mode locking.
Line broadening mechanisms: homogeneous and inhomogeneous broadening. Open resonator and Gaussion beam, stability criterion for optical resonators. Principles of operation of gas, solid state and semiconductor lasers.

Textbook:
As per Course Teacher's recommendation

EEE 521: Optical Waveguide Theory (3.0 credits)
Types of optical waveguides: optical integrated circuits and guiding structures.
Basics of optical waveguide analysis: basic equations for light waves, polarization of light, reflection and
refraction, wave equations. Guided and radiation modes in dielectric slab waveguides. Coupled mode theory.
Analytical solution for optical waveguides: WKB method, Marcatili's method, effective index method, equivalent network method. Computer aided design of integrated optical waveguide devices. Application of photonics to microwave devices. Nonlinear optical waveguides.

Textbook:
As per Course Teacher's recommendation

EEE 523: Non-linear Optics (3.0 credits)
Maxwell's equations: Reflection and refraction at boundaries, Guided waves.
Waveguides: Step-Index Thin-film Waveguides, Three-Dimensional Waveguides, High Index Contrast10 Waveguides, Optical Directional Couplers.
Nonlinear optical susceptibility: Nonlinear optics (NLO), Nonlinear optical processes, Nonlinear susceptibility definition and its properties, Time domain description, Kramers-Kronig relations in linear and nonlinear optics.
Wave equations: Wave equations for nonlinear optical media, Coupled-wave equations, Phase matching, Quasi-phase-matching, Manley-Rowe relations, Sum-frequency generation, Second harmonic generation, Optical parametric oscillators, Electro-optic (Pockels) effect.
Second order NLO $\chi(2)$ materials and devices: Perovskite crystals, Poled polymers, Quasiphasematched (QPM) waveguide frequency doublers, Optical parametric waveguide devices, Integrated electro-optic (IEO) Mach-Zehnder modulators, IEO directional coupler switches.
Third order susceptibility-$\chi(3)$): Wave equation, Tensor nature, Third harmonic generation (THG), Degenerate four-wave mixing (DFWM), Nondegenerate four-wave mixing (NDFWM), Self-focusing, Selfphase modulation (SPM), Cross phase modulation (XPM), Optical Kerr effect (OKE), D.C. Kerr effect, Nonlinear absorption, Complex $\chi(3)$: Brillouin scattering, Complex $\chi(3)$: Raman scattering, $\chi(3)$ materials: Glasses, Semiconductors, Organic/Polymeric.
Nonlinear effects: Non-linear effects in optical fibers including self-phase modulation, nonlinear wave propagation, and solitons. Interaction of light with matter, laser operation, density matrix techniques, nonlinear spectroscopies, and femtosecond optics.

Textbook:
As per Course Teacher's recommendation

EEE 525: Quantum Optics (3.0 credits)
1. Review of Quantum Mechanics, quantization of EM field.

2. Quantum theory of optical coherence: Eigen states of the annihilation operator and minimum uncertainty states, Displaced vacuum states, Wave packets and time evolution, Generation of coherent states, Properties of coherent, states, Quantum entanglement: Generation and detection of entangled states.
3. Squeezed state physics, Squeezed states and the uncertainty relation, The squeeze operator and the squeezed coherent states, Multi-mode squeezing.
4. Quantum Interferometry: Michelson interferometer, Sagnac ring interferometer, etc., Photon detection and quantum coherence functions, First-order coherence, Second-order coherence, Photon counting and photon statistics, Multi-photon interferometry.
5. Atom-field interactions, Interaction of an atom with a classical field and with a quantized
field, The Rabi model, Quantum-mechanical model, The dressed states, Interaction of two level atom with a quantized EM field: Cavity quantum electrodynamics (CQED), high-Q micro-cavity.
6. Lasing without inversion and other effects of atomic coherence and interference.

Textbook:
As per Course Teacher's recommendation

EEE 527: Optical Integrated Circuits (3.0 credits)
1. Optical properties of materials for integrated optoelectronics (IO) and photonics (IP), advantage of optical integrated circuits (OICs), passive optical structures and devices for integrated optics.
2. Types of optical waveguides, materials and optical waveguide fabrication techniques, design of OIC elements (optical switch, optical directional coupler, light divider, light combiner, optical polarizer, and optical isolator), optoelectronic modulators- electro-optically controlled devices properties and technology.
3. Limitations of miniaturization, exact analysis of guided beam in OICs, Some numerical techniques of OICs (Finite element method - FEM, Beam propagation method - BPM, finite difference method FDM).
4. Semiconductor materials and structures applicable for integrated optoelectronics. Active semiconductor devices based on heterostructures, quantum wells and superlattices applicable for integrated optoelectronics. Integrated optoelectronic transmitters and receivers for optical communication systems. Integrated optoelectronic optical systems for recording, processing and display the information.

Textbook:
As per Course Teacher's recommendation

EEE 529: Advanced Digital Image Processing (3.0 credits)
Image Transform: Wavelets, The basic functions, Continuous wavelet transform (CWT), Discrete wavelet transform (DWT). Wavelet decomposition and reconstruction of functions in L2(R). Construction of wavelets, two dimensional DWT, KLT.
Image compression: Fundamental coding theorem, Lossless Compression: Huffman Coding, Arithmetic coding, Bit plane coding, Run length coding, Lossy compression: JPEG, JPEG2000.

Image Segmentation: Pixel classification, Point, Line and Edge detection, Thresholding, Region based segmentation, Segmentation using morphological watersheds and motion.
Object Recognition: Patterns and patterns classes, recognition based on decision theoretic methods, matching, optimum statistical classifiers, neural networks, structural methods.
Color Image Processing: Color fundamentals, color models, pseudo color image processing, color transforms and segmentation.
Morphological Image Processing: Preliminaries, dilation, erosion, open and closing, hit or miss transformation, basic morphologic algorithms.

Textbook:
As per Course Teacher's recommendation

EEE 531: Digital Image Processing (3.0 credits)
Fundamentals of image processing: image formation, representation in pixel and transform domains, reconstruction from projections and interpolation, human visual system, stochastic models for images, enhancement and restoration techniques in spatial and frequency domains, image processing in color space, morphological filters, multi-resolution image processing, image compression techniques and standards, segmentation for edge detection and texture analysis, pattern classification, image watermarking, registration and fusion, emerging applications of image processing.

Textbook:
As per Course Teacher's recommendation

EEE 533: Digital Video Processing (3.0 credits)
Formation and representation of video, spatio-temporal video sampling, motion analysis and estimation: real versus apparent motion, optical flow, block- and mesh-based methods for motion estimation and region-based stochastic motion modeling, motion segmentation and layered video representations, video filtering: motion-compensated filtering, noise reduction, signal recovery, deblurring, superresolution, mosaicing, deinterlacing and frame-rate conversion, video compression techniques and standards, content-based video indexing and retrieval, video communication: digital television, streaming over IP and wireless networks, error control and watermarking, stereo and multiview sequence processing.

Textbook:
As per Course Teacher's recommendation
EEE 535: Digital Speech Processing (3.0 credits)
Speech production and phonetics: speech organs, articulatory phonentics, acoustic theory of speech production, vocal tract models,
Speech analysis: time and frequency domain analysis, formant and pitch estimation
Speech coding: linear predictive coding (LPC), vocoders, vector quantization, speech enhancement techniques
Speech synthesis: formant and LPC synthesizers, effect of different speeches and languages

Automatic speech and speaker recognition: feature extraction, hidden Markov models, noise robustness, measures of similarity, language and accent identification.

Textbook:
As per Course Teacher's recommendation

EEE 537: Broadband Wireless Communications (3.0 credits)
Overview of broadband wireless communications, multiple access techniques - TDMA, FDMA.
Spread spectrum communications - direct sequence spread spectrum (DSSS), FHSS, THSS, modulator and demodulator structure, probability of error, jamming margin, decoding, performance in the presence of interference, PN sequence, CDMA, MC-CDMA, UWB transmission.
Multi-user detection: multiple access interference, detector performance measure - BER, asymptotic efficiency, near-far resistance; detectors - matched filter detector, de-correlator detector, MMSE detector, SIC, PIC, MAP and MLSE detectors. Propagation in mobile radio channels; channel models, fading - large scale and small scale fading, flat fading and frequency selective fading channel, fast fading and slow fading channel; delay spread, Doppler spread and
angle spread; channel autocorrelation functions, scattering function, correlated and uncorrelated scattering (US), WSS and WSSUS model.
Multiple antenna systems, capacity of SISO, SIMO, MISO and MIMO systems, ergodic capacity, outage capacity, STBC, OSTBC, QOSTBC, spatial multiplexing (SM) scheme, SM detection techniques, diversity and diversity combining techniques. Multi-carrier communications; Orthogonal FDM (OFDM), OFDM transceivers. Special issues of OFDM - cyclic prefix, timing offset, frequency offset, synchronization, peak power problem, Broadband wireless standards.

Textbook:
As per Course Teacher's recommendation

EEE 539: Antennas and Propagation (3.0 credits)
Definitions, antenna as antenna as an aperture : arrays of point sources : review of dipoles, loop and thin linear antennas. Helical antenna, biconical and spheroidal antennas. internal-equation methods, current distribution : Self and mutual impedances : arrays : design and synthesis.
Reflector type antennas. Banbiner's principle and complementary antennas. Application of reaction concept and vocational principles in antennas and propagation. Frequency independent antennas. Scattering and diffraction. Selected topics in microwave antennas. Antenna measurements. Application of broadcasting ,microwave links, satellite communication and radio astronomy.

Textbook:
As per Course Teacher's recommendation

EEE 541: Microwave Theory and Techniques (3.0 credits)

Circuit theory for wave guide systems. **N port circuits:** impedance matrix, admittance matrix, scattering matrix and transmission matrix, their properties. Periodic structures and filters: wave analysis, impedance matching, wave and group velocities; **comb lines and their analysis:** introduction to filters, filter design by image parameter and insertion-loss methods; design of different type of filters.

Textbook:
As per Course Teacher's recommendation

EEE 543: MOS Devices (3.0 credits)
The two terminal MOS Structure: flat-band voltage, inversion, properties of the regions of inversion and small signal capacitance. The four terminal MOS structure: charge-sheet model, strong inversion, moderate inversion and weak inversion. Threshold voltage-effects of ion implantation, short channel and narrow width. The MOS transistor in dynamic operation, small signal model for low medium and high frequencies, Charge Coupled devices (CCD).

Textbook:
As per Course Teacher's recommendation

EEE 545: Compound Semiconductor Devices (3.0 credits)
Introduction to GaAs device technology**. GaAs metal-semiconductor field effect transistor (GaAs MESFET)**: introduction, structure, equivalent circuits, current saturation, effect of source and drain resistances, gate resistance and application of GaAs MESFET. **High electron mobility transistor (HEMT):** practical HEMT structure, energy band line-up, equivalent circuit, HEMT noise, pseudomorphic HEMT and applications**. Opto-electronic integration of compound semiconductor devices**: heterojunction phototransistor (HPT) and light amplifying optical switch (LAOS). Low-temperature compound semiconductor electronics. Design consideration of MMICs and power MMICs using compound semiconductor devices.

Textbook:
As per Course Teacher's recommendation

EEE 547: Quantum Phenomena in Nanostructures (3.0 credits)
Fundamentals of quantum mechanics: effective-mass Schrodinger Equation, matrix representation,
Greenis function: Fundamentals of nonequilibrium statistical mechanics: scattering and relaxation.
Carrier transport: density of states, current, tunneling and transmission probabilities, introduction to transport in the collective picture. Basic principles of a few effective devices: resonant tunnel diode, super lattice, quantum wire and dot.

Textbook:
As per Course Teacher's recommendation

EEE 549: VLSI Technology and Device Modeling (3.0 credits)

VLSI si process technology. Si crystal growth and wafer preparation . epitaxial growth on Si substrate. Oxidation of Si. Lithography, diffusion: methods and models. Ion implantation, metallization. Overview and process flow of a CMOS and a BICMOS process. VLSI si devices. Isolation techniques. Second order effects in BJT devices: base width modulation. Emitter current crowding, kirk effect . Second order effects in MOS devices: short channel effects, narrow width effects. Device scaling rules. Device models. Compact models for bipolar devices. Ebers-Moll type model. Gummel-poon type model and their implementation in SPICE. BJT model in SPICE2. Compact models for MOS transistor and their implementation in SPICE. Level 1,2 and 3 MOS model parameters in SPICE. Parameter extraction for bipolar and MOS device models. Geometry, process and temperature dependency of bipolar and MOS model parameters. Parameter optimization, statistics of parameters and statistical modeling.

Textbook:
As per Course Teacher's recommendation

EEE 551: Advanced VLSI Design (3.0 credits)
Trends and issues in high performance digital VLSI design : interconnect as key limiting factor, wire modeling, clock distribution of high speed system, power distribution, crosstalk and power distribution noise. High speed circuit design techniques; Low power design issues; High density and high speed memory design; SOI technology and circuits. VLSI circuits in signal processing; VLSI circuits in wireless communication. ASIC design.

Textbook:
As per Course Teacher's recommendation

EEE 553: Testing VLSI Circuits (3.0 credits)
Physical defects in VLSI Circuits. Complexity and economics of testing. Fault models: Stuck-at, Stack-on, Stack-open, bridging and delay faults. Testing combinational logic circuits : terminologies, path sesicization, fanout and reconvergence, fault matrix , fault collapsing . test generation using D-algorithm, Boolean difference and other methods. Testing sequential logic circ its : problems and remedies . Testability of different types of CMOS circuits for various faults . test invalidation. Robustly testable CMOS circuits . Test generation for static and dynamic CMOS .
Design for testability: different techniques of enhancing testability scan design techniques, built-in self (BIST) Built-in current sensors (BICS) for IDDQ testing of CMOS circuits. Error detecting codes and self-checking circuits.
Testable design of regular array architectures and PLAS: Testable design of regular array architectures and PLAS: the concept of C-testability.

Textbook:
As per Course Teacher's recommendation

EEE 555: Carbon Nanotechnology (3.0 credits)
Nanomaterials and nanostructures: graphene, carbon nanotubes, fullerenes, molecules and organic nanostructures. Synthesis methods of nanostructures: electric arc, pulsed laser deposition, chemical vapor deposition (CVD); thermal CVD, catalytic CVD, micro wave CVD (MWCVD), plasma enhanced CVD (PECVD), spray pyrolysis. Physical and opto-electronic properties; characterization techniques.
Applications: carbon nanotube and graphene based devices, bio-sensors, bio-inspired nanostructures, molecular motors, fuel cells and solar cells.

Textbook:
As per Course Teacher's recommendation

EEE 557: Nano Systems (3.0 credits)
Nanosystems and Devices: Introduction- nanomaterials, nanodevices, nanostructures.
Nanoscale Lithography: X-ray, Electron-Beam and Ion-Beam; Soft Lithography; Scanning Probe Lithography.
Advances in Device Technology: nanoscale silicon devices, process technology, present challenges.
Self Assembled Nanocrystals: self assembly, surface defects and passivation, structures, energy levels, transitions, luminescence and lasing.
Nano Electro Mechanical Systems (NEMS): stress in thin films, mechanical to electrical transduction, surface engineering techniques, process flow, NEMS actuators, high aspect ratio system technology. Nano Biotechnology: scope and dimensions; detection of biological species on electrical, mechanical and optical criteria; Bio functionality on silicon; Biochip sensors and systems- structures, process technology.

Textbook:
As per Course Teacher's recommendation

EEE 559: Thin film Growth and Deposition (3.0 credits)
Introduction to Thin Film Technology. Vacuum systems. Kinetic theory of gases. The physics and chemistry of evaporation/deposition mechanism. Physical vapor deposition and related techniques.
Theories of epitaxy and nucleation, molecular beam epitaxy. Chemical vapor deposition techniques: reaction types, growth kinetics. Liquid phase epitaxy and related techniques. Theories of plasma and discharges. Sputtering (DC, RF and ECR). Solution based deposition techniques (Sol-gel), spray pyrolysis.

Textbook:
As per Course Teacher's recommendation

EEE 561: Semiconductor Characterization Technology (3.0 credits)
Overview of semiconductor technology. Structural characterization: X-ray diffraction (XRD), low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED), atomic force microscopy (AFM), scanning tunneling microscopy (STM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Rutherford backscattering spectroscopy (RBS), energy dispersive x-ray analysis (EDX), Auger electron spectroscopy (AES), electron energy loss spectroscopy (EELS), secondary ion mass spectroscopy (SIMS), X-ray photoelectron spectroscopy (XPS), elastic recoil detection (ERD). Electrical

characterization: resistivity measurements, Hall measurement, current-voltage (I-V), capacitance-voltage (C-V), deep level transient spectroscopy (DLTS), lifetime measurements. Optical characterization: optical transmittance and reflectance spectroscopy, ellipsometry, photoluminescence (PL), Raman spectroscopy, Fourier transform infrared spectroscopy.

Textbook:
As per Course Teacher's recommendation

EEE 563: Electric and Magnetic Properties of Materials (3.0 credits)
Electric Properties: Polarization, electrical conductivity and dielectric losses. Pyroelectric phenomena . piezoelectric effect and electrostriction. Domain structure and peculiarities electric properties of ferroelectrics and anti-ferroelectrics. Structure and properties of some ferroelectrics and antiferroelectrics. Phase transition in ferroelectrics, fundamentals of spontaneous polarization theory.
Magnetic Properties: Disordered magnetics, ordered magnetics. Domain structure of ferromagnetic crystals and magnetization processes. Anisotropy of ferroelectric crystals. Structure of some magnetically ordered crystals and reorientation transition. Piezomagnetic and magnetoelectric effect

Textbook:
As per Course Teacher's recommendation

EEE 565: Semiconductor Materials and Heterostructures (3.0 credits)
Residual impurities in silicon wafers, zone refining. Crystal imperfections: structural, optical and electronic properties . Implantation related defects, recovery of crystal structure, solid phase epitaxial regrowth (SPE).
Semiconductor alloys: Structural and electronic properties: growth techniques-molecular beam epitaxy (MBE). Chemical vapour deposition (CVD): pseudomorphic and metastable structures, tetragonal distortion. Strain relaxation. Structural and optical properties of double sided heterostructures, quantum wells and superlattices; types of band alignment. Solid state
heterostructural LED and LASER. optoelectronic Functionality in silicon chip. Structural and electrical study of heterojunction bipolar transistor (HBT), heterojunction avalanche photodiode, and silicon-germanium MOSFET.

Textbook:
As per Course Teacher's recommendation

EEE 567: Energy Conversion(3.0 credits)
Energy conversion processes; general introduction, energy sources, principles or conservation of energy balance equations.
Direct electrical energy conversion: introduction: magnetohydronamic (MHD): fuel cell: thermoelectrostatic: ferro-electric: photo-electric: photovoltaic, electrostatic and piezoelectric energy conversions: characteristics including efficiency, power densities, terminal properties and limitations. Electromechanical energy conversion: general introduction of electrical to mechanical, mechanical to electrical and electrical to electrical conversions. Bulk energy conversion devices. General formulations of equations; co-ordinate transformation and terminal characteristics.

Textbook:
As per Course Teacher's recommendation

EEE 569: Power Semiconductor Circuits (3.0 credits)
Static switching devices, characteristics of SCR, BJT, MOSFET, IGBT, SIT, GTO, MCT. Classifications of static power converters and their application. Control circuits for static power converters.
Pulse width modulation; PWM control of static power converters. Switch mode DC to DC converters, resonant converters, Fourier analysis of static converter waveforms, HD, THD, pf, ZVS and ZCS of static converters. Hysteresis current of AC drives.

Textbook:
As per Course Teacher's recommendation

EEE 571: Design of Power Semiconductor Circuits and Drives (3.0 credits)
Design of SCR communication circuits, base and gate drive circuits of static switching devices, snubber circuits, switching losses and heat sink. Input/output filter design of static power converters. Design of protection circuits for static power converters. Scalar and vector control of AC machines using static power converters. Design of microcomputer controllers for static power converter switching.

Textbook:
As per Course Teacher's recommendation

EEE 573: Special Machines (3.0 credits)
Course will be broadly on current topics on electrical machines and devices. The following areas will be covered: permanent magnet machines. Hysteresis machine. **Eddy current devices**: homopolar machines. PAM motors and reluctance machines.

Textbook:
As per Course Teacher's recommendation

EEE 575: Advanced Machines Design (3.0 credits)
General treatment of Electrical Machine Design. Review of standard procedures in design of DC machines. AC machines, transformers and special machines. Optimization and synthesis of design procedures. Applications of material balance and critical path principles in electrical design.
Design economics and safety factors. Applications of computers in modern designs including the operation of the machine in the nonlinear ranges: Magnetic flux-plots and heat transfer process etc.
Mechanical design of electrical machinery and relation between machanical and electrical machine design.

Textbook:
As per Course Teacher's recommendation
EEE 577: Power System Stability (3.0 credits)

Principles of angular and voltage stability. Methods of multi machine transient stability: direct methods and time domain simulation. Equal area criterion. Extended equal area criterion, transient energy function (TEF) methods. Nonlinear system stability- Lyapunov's method. State space concepts and dynamic system representation. Eigen vectors in dynamic system analysis. Detailed modeling, simplifications, salient synchronous machines and induction machines modeling.
Turbine governor, generator excitation systems and their representation in stability models. Power system stabilizers. On line identification and improvement of stability through on line control.

Textbook:
As per Course Teacher's recommendation

EEE 579: Transients in Power Systems (3.0 credits)
Transients in simple electric and magnetically linked circuits, fundamentals: impacts of switching on rotating machinery. Parallel operation of interconnected networks; distribution of power impacts. Interaction of Governor's in power systems. Overvoltage during power system faults. Systems voltage recovery characteristics. Effect of arc restriking on recovery voltage. Switching surges and overvoltage caused by sudden loss of load and by open conductor.

Textbook:
As per Course Teacher's recommendation

EEE 581: Reliability of Power System (3.0 credits)
Review of basic probability theory. Basic reliability concepts. Markovian model of generation unit. Development of load models. Probabilistic simulation of generating systems. Reliability indices. Recursive, segmentation and cummulant method to obtain loss of load probability (LOLP). Modeling of forecast uncertainty. Reliability evaluation of energy limited systems. Different techniques of evaluating reliability, reliability indices of interconnected systems. Composite transmission and generating system reliability.

Textbook:
As per Course Teacher's recommendation

EEE 583: Energy Resources & Technologies (3.0 Credits)
Energy and Renewable Energy Fundamentals, Renewable Energy Technology, Geothermal Energy, Energy Cooperation, Solar Distillation, Solar Radiation, Flat Plate Collector, Hydro
Power, Fuel Cell, Biomass Energy, Tidal Energy, Magneto hydro dynamic Generator, Fluid Mechanics, Basic Fluid Dynamics, Pipe Flow and Open Channel Flow, GIS, Inverter, Remote Sensing, Role of GIS, Fuel Cell, Introduction to GPS.

Textbook: As per Course Teacher's recommendation

EEE 585: Solar Thermal Energy and System (3.0 Credits)
Battery and Energy Storage, Electric Double Layer Capacitor (EDLC) and ECS, Storage System, Charge Controller, Economic Analysis, Energy Storages, Solar Cooking, Solar Thermal, Thermal Physics, Solar Desalination, Carnot Cycle, Design

of a Solar Water Heater, Energy Economics, Flat Plate Collectors, Flat Plate Collectors for Solar Thermal Systems, passive-cooling-techniques, passive Heating, Thermal processes, Refrigeration using PV, Solar Air heating, Solar Collectors and Applications, Solar Domestic Hot Water, Solar industrial process heat, Solar powered desalination, Solar Refrigeration, Solar Thermal concentrator, Solar Thermal System, Water Heating, Water Desalination.

Textbook:
As per Course Teacher's recommendation

EEE 587: Climatology (3.0 credits)
Sun-earth astronomical relationships, Estimation of diffuse radiation, Global solar radiation, Extraterrestrial radiation, Position of the sun relative to the horizontal surface, Estimation of total radiation on an inclined surface, Atmospheric turbidity, Climate Change and policies-2016, Climate system and its components 2016, CO2 mitigation analysis, Earth's radiation balance with a greenhouse atmosphere. Greenhouse gases, Wind data assessment and reporting.

Textbook:
As per Course Teacher's recommendation

EEE 589: Technologies and Energy Management in Buildings (3.0 Credits)
Boiler, Building comfort, Energy efficiency Green building Design, Passive solar Building Design, PV in Architecture, Climate mitigation, Cogeneration, Cooling concept and psychometric chart, Energy audit, Lighting, Power factor, Refrigeration and solar refrigeration system, Windows.

Textbook:
As per Course Teacher's recommendation

EEE 591: Materials and Devices for Energy Applications (3.0 Credits)
Crystals, Crystal growth, Czochralski Process of Silicon Wafers, Energy levels, Mono-crystalline Si wafer growth, Periodic Table, Photolithography, Si wafer growth, Standard solar cell preparation, Thin film characterization, Thin film deposition, Thin film solar cells aSiH.

Textbook:
As per Course Teacher's recommendation

EEE 593: Energy Economics (3.0 Credits)
Introduction to Energy Economics, Energy Data and Energy Balance, Understanding and Analyzing Energy Demand, Energy Demand Management, Economic Analysis of Energy Investments, Economics of Fossil Fuel Supply, Non-Renewable Resource Supply, Electricity Supply, Renewable Energy Supply, Energy Markets and Principles of Energy Pricing, Energy
Pricing and Taxation, Overview of Global Energy Challenges, Impact of High Energy Prices, Energy Security Issues, Investment Issues in the Energy Sector, Regulation of Energy Industries.

Textbook:
As per Course Teacher's recommendation

EEE 595: Research Methodology (3.0 Credits)
Fundamentals of Research, Basic Concepts and Issues of Research, Research Process, Designing a study, Statistical Tools in Research, Hypothesis Testing, Developing proposal and writing report, Data Analysis, Monitoring and Evaluation.
Textbook:
As per Course Teacher's recommendation

EEE 598: Renewable Energy Lab (3.0 Credits)
1.Installation of CampbellStokes sunshine duration recorder and measurement of sunshine duration data from burning cards
2.Prediction of Direct Normal Irradiance from measured total and diffuse radiation on a horizontal surface and comparison of computed values with experimentally measured values
3.Prediction of total solar radiation on a tilted surface from measured values of total and diffuse solar radiation on a horizontal surface
4.Evaluation of a site for wind power generation
5.Feasibility study of a wind farm using RET Screen
6.Measurement of Open circuit voltage, Short circuit current, efficiency
7.Maximum power point and Fill factor for different solar radiation of a solar cell or module
8.Performance study of a charge controller
9.Performance study of a battery
10.Performance study of an Inverter
11.Design, construction and performance study of a solar home system
12.Performance study of a grid connected solar system
13.Feasibility study of a off grid solar PV system using RET Screen
14.Feasibility study of a Solar Water Heating System using RET Screen
15.Performance study of a solar water heating system
16.Performance study of a solar cooker
17.Techno economical study of a PV-Wind-Generator hybrid system using HOMER.

EEE 510: Viva Voce (2.0 Credits)
Viva examination with external evaluation about the courses taken

Project and Independent Study

EEE 602 (3 Credits)
INDEPENDENT STUDY I (Thesis)/ Project

Research work approved by GSC and BAS

EEE 604 (3 Credits)
INDEPENDENT STUDY II (Thesis)/ Project

Research work approved by GSC and BAS

EEE606 (3 Credits)
INDEPENDENT STUDY III (Thesis)/ Project

Research work approved by GSC and BAS