COURSE BOOKLET

3rd Year Electrical Engineering

Department of Electrical Engineering

श्रमम् बिना न किमपि साध्यम्

Table of Content

Sl. No.	Topic
1.	Departmental Vision
2.	Departmental Mission
3.	Departmental UG Level Programme Outcomes (PO's)
4.	Departmental UG Level Programme Educational Objectives (PEO's)
5.	Departmental UG Level Programme Specific Outcomes (PSO's)
6.	Correlation Matrix between PEOs and Mission of the Department of Electrical Engineering, RCCIIT
7.	Formulation of Course structure
8.	UG Level Programme Curriculum Structure for Odd Semester
9.	Course Articulation Matrix for all 1st year Odd semester Courses
10.	UG Level Course details of all 1st year Odd semester Courses
11.	UG Level Programme Curriculum Structure for Even Semester
12.	Course Articulation Matrix for all 1st year Even Courses
13.	UG Level Course details of all 1st year Even semester Courses

About the Department

The Department of Electrical Engineering (which is now accredited by National Board of Accreditation (NBA), New Delhi) started its journey in the year 2009 under RCCIIT and the first batch of students graduated in the year 2013. It is situated in the ground floor of the new campus of the Institute. The department offers Electrical Engineering (EE) undergraduate program that augments the liberal education to undergraduates and imparts well understanding of the subject, Electrical Engineering and its different aspects built on a foundation of Science, Mathematics, Computation, Engineering and Technology. Admissions for UG program in this department require a valid rank of WBJEE/AIEEE which is monitored through the Institutional Admission Committee following the guidelines of the Maulana Abul Kalam Azad University of Technology, previously known as the West Bengal University of Technology. The department also take admission under lateral entry scheme from the merit list of JELET conducted by West Bengal Joint Entrance Examinations Board. The present intake of this department is 60. The department has highly qualified and experienced faculty and staff members. The Department has well modernized class rooms, Faculty rooms and possesses exclusive laboratories as per university course curriculum. Apart from the academics, students are also encouraged for different extra-curricular activities like quizzes, seminars, workshops etc.

Faculty Profile

Dr. Shilpi Bhattacharya (HoD)

Associate Professor

Power Electronics, Drives

Dr. Debasish Mondal

Professor

Control System, Field Theory

Dr. Alok Kole

Professor

AI ML, Control System

Dr. Dipankar Santra

Associate Professor

Measurement, Machine

Mr. Budhaditya Biswas (PC)

Assistant Professor

Power System

Mr. Nijam Uddin Molla

Assistant Professor

Electric Machine

Mr. Sarbojit Mukherjee

Assistant Professor

Power Electronics, Drives

Mr. Subhasish Banerjee

Assistant Professor

Non-Conventional Energy

Dr. Shilpi Bhattacharya (HoD)

Assistant Professor

Microcontroller, FPGA

Non Teaching Staff Profile

Mr. Ashim Biswas

Lab Technician

Basic Electrical, Machine

Mr. Soumitra Dey

Lab Technician

Thermal Power, Power System

Mr. Rajesh Mahato

Lab Technician

Control System, Circuit Theory

Mr. Sumit Mukherjee

Technical Assistant

Power Electronics, Drives

Mr. Abir Sen

General Assistant

Vision of the Program (Electrical Engineering)

To create world class professionals who are globally competitive, capable of using and developing state-of-the-art technologies along with research and innovation in EE and allied fields.

Mission of the Program (Electrical Engineering)

M1: To provide education to the students that will enable them to meet the current and future needs of EE and possess diverse capabilities to pursue their careers successfully.

M2: To be research and innovation oriented so as to investigate and develop new technologies.

M3: To remain constantly agile to the needs of industry, environment and society so as catered to the needs of the nation and the global community.

Program Outcome (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, give and receive clear instructions.

11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Educational Objectives (PEOs)

The graduate will posses:

- Basic understanding of core electrical engineering built on foundation of physical science, mathematics, computing, and technology so as to pursue successful career/higher studies in Electrical Engineering.

- Broad based knowledge of Electrical Engineering suitable for research, development and innovation to meet diverse and multidisciplinary needs of industry and society.

- Adequate professional skills, to be analytical and logical so that they can quickly adapt to new work environment, assimilate information and solve challenging problems.

- Self-learning capability, leadership qualities with strong communication skills and working in teams.

- Capacity to be productive with ethical values, conscious about social and environmental issues with lifelong learning attitude.

Program Specific Outcome (PSOs)

At the end of the program, the students

PSO1: Proficiency in use of software & hardware required to practice Electrical engineering profession.

PSO2: Proficiency in developing wind & solar hybrid power generating systems.

PSO3: Development of wireless control & automation and real time simulations for prototypes.

Correlation between Program Educational Objectives (PEOs) and Mission of the Department of Electrical Engineering, RCCIIT

PEO No.	Statement	M1	M2	M3
PEO 1	Basic understanding of core electrical engineering built on foundation of physical science, mathematics, computing, and technology so as to pursue successful career/higher studies in Electrical Engineering.	3	3	3
PEO 2	Broad based knowledge of Electrical Engineering suitable for research, development and innovation to meet diverse and multidisciplinary needs of industry and society.	3	3	3
PEO 3	Adequate professional skills, to be analytical and logical so that they can quickly adapt to new work environment, assimilate information and solve challenging problems.	2	3	3
PEO 4	Self-learning capability, leadership qualities with strong communication skills and working in teams.	3	3	2
PEO 5	Capacity to be productive with ethical values, conscious about social and environmental issues with lifelong learning attitude.	3	2	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

Marks Division for Theory Examination

```
                          ┌─────────────────┐
                          │     FM 100      │
                          └────────┬────────┘
              ┌────────────────────┴────────────────────┐
      ┌───────────────┐                          ┌─────────────────┐
      │ Internal (30) │                          │    Semester     │
      └───────┬───────┘                          │  Examination    │
              │                                  │      (70)       │
              │                                  └────────┬────────┘
      ┌───────────────┐                          ┌─────────────────┐
      │     CA1       │                          │ Short answer    │
      │ (Presentation)│                          │ type questions  │
      │     (25)      │                          │ (1 marks ×10)   │
      └───────────────┘                          │    = 10         │
                                                 └─────────────────┘
      ┌───────────────┐                          ┌─────────────────┐
      │ CA 2 (Report  │                          │ Midium answer   │
      │ Writing) (25) │                          │ type questions  │
      └───────────────┘                          │ (5 marks × 3) = │
                                                 │      15         │
                                                 └─────────────────┘
      ┌───────────────┐                          ┌─────────────────┐
      │ CA 3 (Written │                          │ Long answer     │
      │  Exam) (25)   │                          │ type questions  │
      └───────────────┘                          │ (15 marks × 3)  │
                                                 │     = 45        │
      ┌───────────────┐                          └─────────────────┘
      │ CA 4 (Online  │
      │  MCQ) (25)    │
      └───────────────┘
```
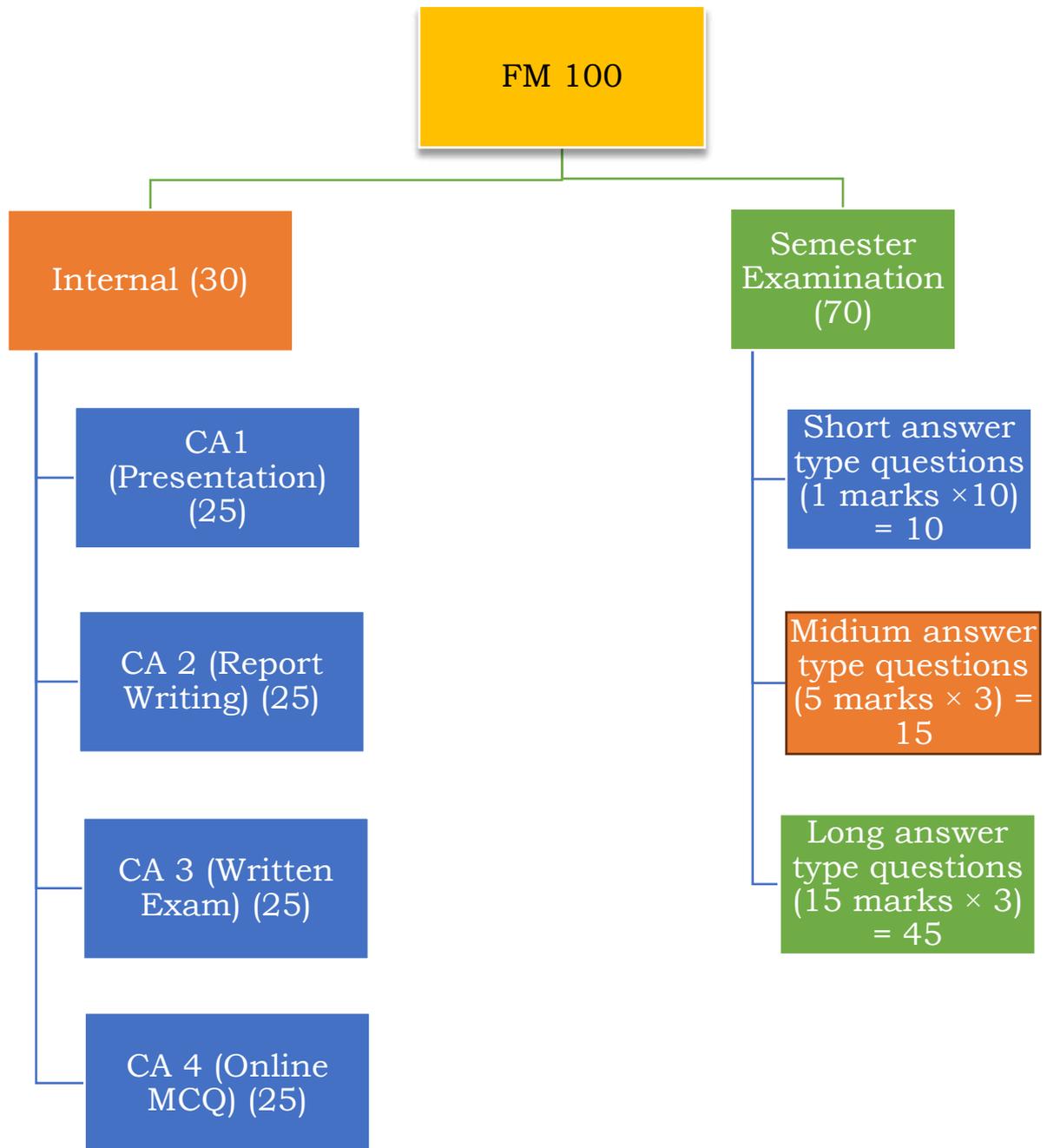
University takes 4 **Continuous Assessments (CA)** out of 25 and they scale it within 30 marks in the final result.

Marks Division for Practical Examination

```
                              ┌──────────────┐
                              │   FM-100     │
                              └──────┬───────┘
          ┌──────────────────────────┴─────────────────────────┐
┌──────────────────┐                              ┌──────────────────┐
│   Continuous     │                              │    Semester      │
│   Evaluation     │                              │   Examination    │
│   (FM - 40)      │                              │    (FM - 60)     │
└──────────────────┘                              └──────────────────┘
```

Continuous Evaluation (FM - 40)	Semester Examination (FM - 60)
Lab Report (10)	Viva (20)
Continuous Performance (5)	Conduct of the experiment (15)
Viva (20)	Calculation / Graph (10)
Attendance (5)	Report + analysis (15)
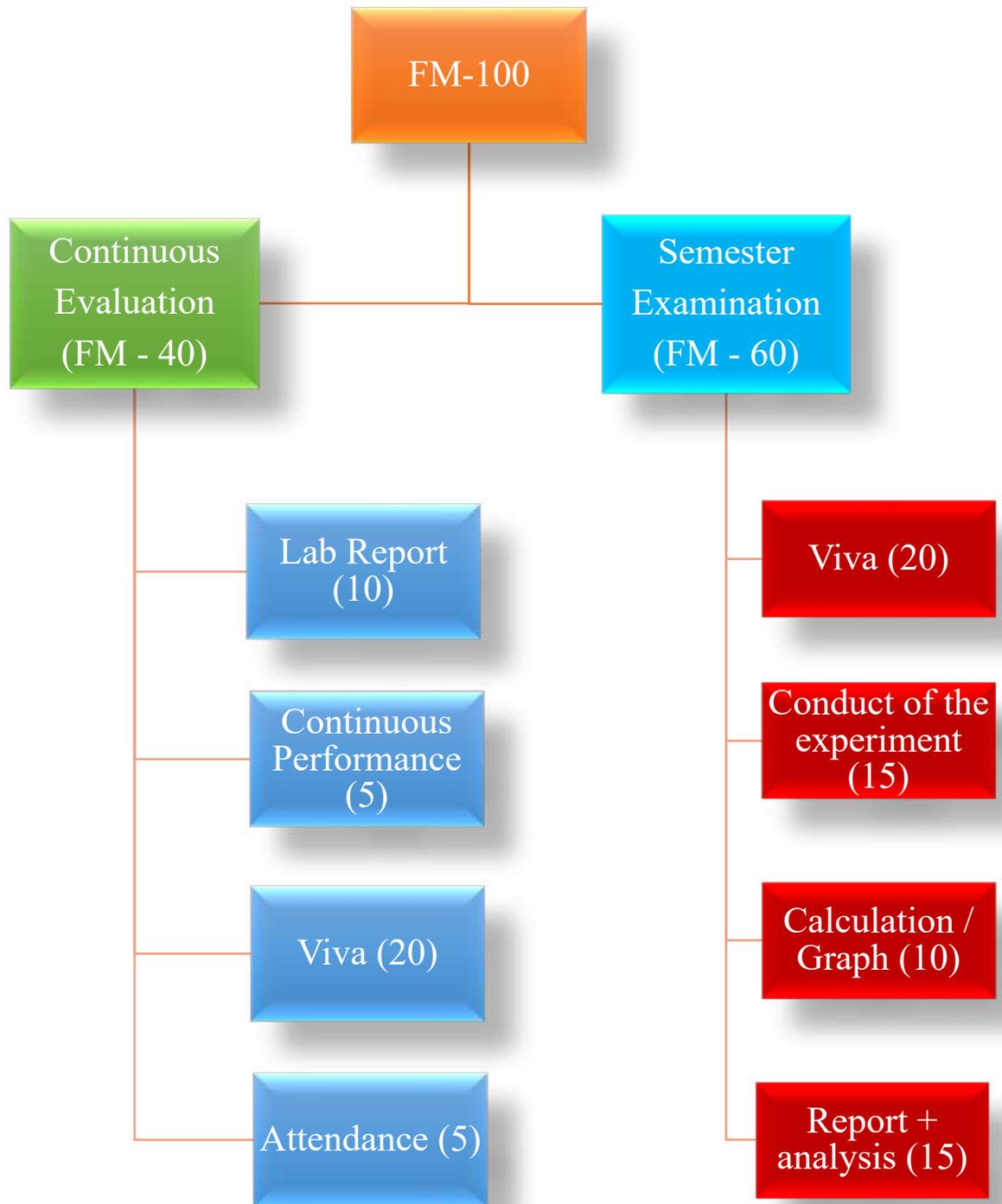
University takes 2 **Practical Continuous Assessment (PCA)** during the semester.

Course Structure

Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits

Range of credits:

A range of credits from 150 to 160 for a student to be eligible to get B.Tech Degree in Engineering. A student will be eligible to get B.Tech Degree with Honours, if he/she completes an additional 20 credits. These could be acquired through Massive Open Online Courses (MOOCs).

MOOCs for B. Tech Honours:

The additional 20 credits (for obtaining B. Tech with Honours) are to be gained through MOOCs. The complete description of the MOOCs relevant for the first year course are given in **Annexure-I**. The courses for subsequent years of study will be posted subsequently.

Guidelines regarding Mandatory Induction Program for the new students:

All concerned are requested to follow the guidelines given in **Annexure-II** concerning Mandatory Induction Program. The colleges/ Institute may also refer to the AICTE Model Curriculum for Undergraduate Degree Courses in Engineering & Technology

Mandatory Additional Requirement for earning B. Tech Degree:

All concerned are requested to follow the guidelines in **Annexure-III** concerning Mandatory Additional Requirements.

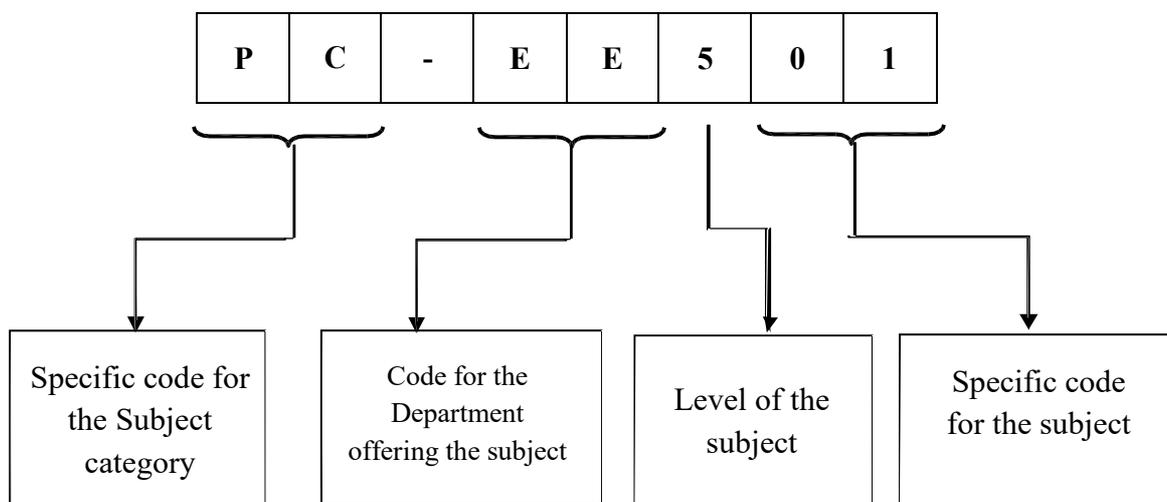**Group division:**

Group-A:

Chemistry based subjects:

[Bio-Technology, Food Technology, Leather Technology, Textile Technology, Ceramic Technology, Chemical Engineering, and any other Engineering that chooses to be Chemistry based] + Physics based subjects: [Mechanical Engineering, Production Engineering, Civil Engineering, Automobile

Engineering, Marine Engineering, Apparel Production Engineering, Computer Science & Engineering, Information Technology.]

Group-B:

All Physics based subjects which are also Electrical & Electronics based [**Electrical Engineering**, Electronics & Communication Engineering, Applied Electronics & Instrumentation Engineering, Power Engineering, Electrical & Electronics Engineering, Bio- Medical Engineering, Instrumentation & Control Engineering]

Subject Numbering Scheme:

P	C	-	E	E	5	0	1

Specific code for the Subject category	Code for the Department offering the subject	Level of the subject	Specific code for the subject

List of Codes for Subject Category	
Code	**Category Name**
BS	Basic Science Courses
E	Engineering Science Courses
HM	Humanities and Social Sciences including Management courses
PC	Professional core courses
PE	Professional Elective courses
OE	Open Elective courses
MC	Mandatory courses
PW	Project

3rd Year First Semester

Theory

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 501	Electric machine-II	3	0	0	3	3
2	PC-EE 502	Power system-I	3	0	0	3	3
3	PC-EE 503	Control system	3	0	0	3	3
4	PC-EE 504	Power electronics	3	0	0	3	3
5	PE-EE 501	A. High voltage B. Engineering C. Power Plant Engineering D. C. Renewable & Non-conventional energy	3	0	0	3	3
6	OE-EE 501	A. Data structure & algorithm B. Object oriented programming C. Computer organization & architecture	3	0	0	3	3
		TOTAL OF SEMESTER:				18	18

Practical

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 591	Electric Machine-II laboratory	0	0	2	2	1
2	PC-EE 592	Power system-I laboratory	0	0	2	2	1
3	PC-EE 593	Control system laboratory	0	0	2	2	1
4	PC-EE 594	Power Electronics laboratory	0	0	2	2	1
		Total of Practical / Sessional				08	4
		TOTAL OF SEMESTER:				26	22

3rd Year Second Semester

Theory

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 601	Power System-II	3		0	3	3
2	PC-EE-602	Microprocessor & micro controller	3	0	0	3	3
3	PE-EE 601	A. Digital control system B. HVDC transmission C. Electrical Machine Design	3	0	0	3	3
4	PE-EE 602	A. A. Electrical and Hybrid vehicle B. Power quality & FACTS C. Industrial Electrical systems	3	0	0	3	3
5	OE-EE 601	A. Digital Signal Processing B. Communication Engineering C. VLSI & Microelectronics	3	0	0	3	3
6	HM-EE 601	Economics for Engineers	3	0	0	3	3
		TOTAL OF SEMESTER:				18	18

Practical

Sl. No.	CODE	Paper	Contact periods Per week			Total Contact Hrs	Credits
			L	T	P		
1	PC-EE 691	Power system-II laboratory	0	0	2	2	1
2	PC-EE692	Microprocessor & microcontroller laboratory	0	0	2	2	1
3	PC-EE 681	Electrical & Electronic design laboratory	1	0	4	5	3
		Total of Practical / Sessional				09	05
	TOTAL OF SEMESTER:					27	23

Third Year First Semester Articulation Matrix

Sl. No.	NBA Code	Subject Code	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	PSO 1	PSO 2	PSO 3
1	C301	PC-EE 501	2.0	1.8	1.7	1.0	1.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	1.0	0.0	0.0
2	C302	PC-EE 502	2.0	1.8	2.0	1.0	0.0	1.0	1.0	0.0	0.0	0.0	1.0	1.0	0.0	2.0	0.0
3	C303	PC-EE 503	3.0	2.5	2.3	1.8	2.4	2.0	2.0	1.0	2.0	2.3	2.8	2.7	3.0	2.7	2.7
4	C304	PC-EE 504	3.0	2.2	1.8	1.0	1.3	1.0	1.0	0.0	1.8	1.0	0.0	2.2	2.5	2.5	1.5
5	C305	OE-EE-501A	3.0	2.0	1.7	1.3	2.0	2.0	2.0	233.0	2.2	1.8	2.2	2.0	2.5	2.3	2.3
6	C306	PE-EE-501C	3.0	1.8	1.7	2.0	1.0	3.0	3.0	1.0	0.0	0.0	1.8	1.0	1.0	3.0	1.0
7	C307	PC-EE 591	1.8	1.6	1.6	1.0	0.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.6	0.0	0.0
8	C308	PC-EE 592	1.5	1.7	1.3	1.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	1.0	0.0	0.0
9	C309	PC-EE 593	2.55	1.97	1.74	1.36	1.66	1.80	1.80	0.00	0.00	0.00	1.94	1.77	1.93	2.62	1.87
10	C310	PC-EE 594	3.0	2.2	2.8	1.8	2.3	1.0	0.0	0.0	1.8	1.0	1.3	1.0	2.5	2.3	1.0

Third Year Second Semester Articulation Matrix

Sl. No.	NBA Code	Subject Code	CO 1	CO 2	CO 3	CO 4	CO 5	CO 6	CO 7	CO 8	CO 9	CO 10	CO 11	CO 12	PSO 1	PSO 2	PSO 3
1	C311	PC-EE-601	1.8	2.7	2.8	1.3	2.5	1.0	2.0	1.0	2.0	0.0	0.0	1.5	1.8	1.3	2.2
2	C312	PC-EE-602	3.0	2.5	2.2	1.5	3.0	1.5	1.5	0.0	1.8	1.8	1.5	1.7	2.2	2.3	2.7
3	C313	PE-EE-601A	3.0	2.7	2.5	2.5	2.4	1.4	1.8	1.0	2.0	2.3	2.7	2.7	3.0	2.5	2.7
4	C314	PE-EE-602A	3.00	2.50	1.67	1.50	2.20	1.50	1.00	1.00	3.00	2.00	2.33	3.00	2.50	2.67	1.83
5	C315	OE-EE-601A	3.0	2.8	2.8	2.5	1.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.2
6	C316	HM-EE-601	1.8	2.3	2.2	1.6	2.0	0.0	0.0	0.0	3.0	0.0	0.0	2.0	2.0	1.7	0.0
7	C317	PC-EE 691	2.0	2.0	2.2	1.6	2.0	0.0	0.0	0.0	3.0	0.0	0.0	1.5	1.8	2.0	2.3
8	C318	PC-EE 692	3.0	2.5	2.8	1.8	2.2	1.0	1.0	0.0	1.5	1.0	1.0	1.0	2.2	2.0	2.5
9	C319	PC-EE 681	3.0	2.8	2.8	2.5	1.5	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	1.2

Name of the course	ELECTRIC MACHINE-II
Course Code: PC-EE-501	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Course Objective:

1.	To understand the arrangement of windings of AC machines.
2.	To understand the principle of production of pulsating and revolving magnetic fields.
3.	To understand the principle of operation and characteristics of three phase Induction machines
4.	To understand the principle of operation and characteristics of single phase Induction machines
5.	To understand the principle of operation and characteristics of synchronous machine
6.	To understand the principle of operation and characteristics of special electromechanical devices.
7.	To solve problems of Induction machines, synchronous machines and special electro-mechanical devices.

Pre-Requisite:

Basic Electrical Engineering (ES-EE-101)
Electric Circuit Theory (PC-EE-301)
Electromagnetic field theory (PC-EE-303)
Electric Machine-I (PC-EE-401)

Course Outcomes:

CO1	describe the arrangement of winding of AC machines.
CO2	explain the principle of operation of Induction machines, Synchronous machines and special machines.

CO3	solve numerical problems of Induction machines, Synchronous machines and Special machines.
CO4	estimate the parameters and efficiency of Induction machines and Synchronous machines.
CO5	determine the characteristics of Induction machines and Synchronous machines.
CO6	select appropriate methods for starting , braking and speed control of Induction machines.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	2	1	1	1	1	1	1		0	0	0	0		1		
CO2	2	2	1	1										1		
CO3	2	2	2		1		1				1	1		1		
CO4	2	2	2		1									1		
CO5	2	2	2	1		1								1		
CO6	2	2	2		1									1		
Avg	**2.00**	**1.83**	**1.67**	**1.00**	**1.00**	**1.00**	**1.00**	**0.00**	**0.00**	**0.00**	**1.00**	**1.00**		**1.00**	**0.00**	**0.00**

Detail Syllabus:

Unit	Content	Hrs
1	**Fundamentals of AC machine windings:** Physical arrangement of windings in stator and cylindrical rotor; slots for windings; single-turn coil - active portion and overhang; full-pitch coils, concentrated winding, distributed winding, winding axis,3D visualization of the above winding types, Air-gap MMF distribution with fixed current through winding-concentrated and distributed, Sinusoidally distributed winding, winding distribution factor	5
2	**Pulsating and revolving magnetic fields:** Constant magnetic field, pulsating magnetic field - alternating current in windings with spatial displacement, Magnetic field produced by a single winding - fixed current and alternating current Pulsating fields produced by spatially displaced windings, Windings spatially shifted by 90 degrees, Addition of pulsating magnetic fields, Three windings spatially shifted by 120 degrees (carrying three-phase balanced currents), revolving magnetic field.	5

3	**Induction Machines:** Construction, Types (squirrel cage and slip-ring), Torque Slip Characteristics, Starting and Maximum Torque. Equivalent circuit. Phasor Diagram, Losses and Efficiency. Effect of parameter variation on torque speed characteristics (variation of rotor and stator resistances, stator voltage, frequency). Methods of starting, braking and speed control for induction motors. Generator operation. Self-excitation. Doubly-Fed Induction Machines.	10
4	**Single-phase induction motors:** Constructional features, double revolving field theory, equivalent circuit, determination of parameters. Split-phase starting methods and applications	5
5	**Synchronous machines:** Constructional features, cylindrical rotor synchronous machine - generated EMF, equivalent circuit and phasor diagram, armature reaction, synchronous impedance, voltage regulation. Operating characteristics of synchronous machines, V-curves. Salient pole machine - two reaction theory, analysis of phasor diagram, power angle characteristics. Parallel operation of alternators - synchronization and load division.	10
6	**Special Electromechanical devices:** Principle and construction of switched Reluctance motor, Permanent magnet machines, Brushless DC machines, Hysteresis motor, Stepper motor, Tacho generators.	5

Text books:

1. Electrical Machines -II , P.S. Bimbhra, Khanna Book Publishing House.
2. Electrical Machinery, P.S. Bimbhra, Khanna Publishing House.
3. Electrical Machines, Nagrath & Kothary, TMH
4. Electrical Machines, P.K. Mukherjee and S. Chakravorti, Dhanpat Rai Publications.
5. Electrical Machines, Theory & Applications, M.N. Bandyopadhyay, PHI

Reference books

1. Electric Machinery & Transformer, Bhag S. Guru and H.R. Hiziroglu, 3rd Edition, Oxford University press.
2. Electric Machinery & Transformes, Irving L. Kosow, PHI

3. Electric Machinery, A.E.Fitzgerald, Charles Kingsley,Jr. & Stephen D. Umans, 6th Edition, Tata McGraw Hill Edition.
4. Electrical Machines, R.K. Srivastava, Cengage Learning
5. Theory of Alternating Current Machinery, Alexander S Langsdorf, Tata Mc Graw Hill Edition
6. The performance and Design of Alternating Current Machines, M.G.Say, CBS publishers & distributors
7. Electric Machines, Charles A. Gross, CRC press.
8. Problems in Electrical Engineering, Parker smith, 9th Edition, CBS publishers & distributors.

Name of the course	POWER SYSTEM-I
Course Code: PC-EE-502	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs/week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Course Objective:

1.	To understand the basic principle of generation of Electricity from different sources
2.	To find parameters and characteristics of overhead transmission lines and cables.
3.	To find different parameters for the construction of overhead transmission line
4.	To determine the performance of transmission lines.
5.	To understand the principle tariff calculation.
6.	To solve numerical problems on the topics studied.

Pre-Requisite:

1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-EE-301)
3.	Electromagnetic field theory (PC-EE-303)

Course Outcomes:

CO1	Explain the principle of generation of Electric power from different sources.
CO2	Determine parameters of transmission lines and its performance.
CO3	Explain the principle of formation of corona and methods of its reduction.
CO4	Conduct electrical tests on insulators.
CO5	Solve numerical problems related to overhead transmission line, cable, insulators and tariff .
CO6	Analyze overhead transmission line based on short medium and long lines.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	2	2	2	1		1	1				1	1			2	
CO2	2	2	2	1											2	
CO3	2	0				1	1									
CO4	2	1														
CO5	2	2				1								2	2	2
CO6	2	2	2													1
Avg	2.00	1.80	2.00	1.00	0.00	1.00	1.00	0.00	0.00	0.00	1.00	1.00		0.00	2.00	0.00

Detail Syllabus:

Unit	Content	Hrs
1	**Basic Concepts:** Evolution of Power System and present day Scenario. Structure of power system: Bulk power grid and Micro Grid. **Generation of Electric Power:** General layout of a typical coal fired power station, Hydro electric power station, Nuclear power station, their components and working principles, comparison of different methods of power generation. Introduction to Solar & Wind energy system. **Indian Electricity Rule-1956:** General Introduction.	10
2	**Overhead transmission line:** Choice of frequency, Choice of voltage, Types of conductors, Inductance and Capacitance of a single phase and three phase symmetrical and unsymmetrical configurations. Bundle conductors. Transposition. Concept of GMD and GMR. Influence of earth on conductor capacitance. **Overhead line construction:** Line supports, Towers, Poles, Sag, Tension and Clearance, Effect of Wind and Ice on Sag. Dampers. **Corona:** Principle of Corona formation, Critical disruptive voltage, Visual critical corona discharge potential, Corona loss, advantages & disadvantages of Corona. Methods of reduction of Corona.	12

3	**Insulators:** Types, Voltage distribution across a suspension insulator string, String efficiency, Arching shield & rings, Methods of improving voltage distribution across Insulator strings, Electrical tests on line Insulators.	5
4	**Cables:** Types of cables, cable components, capacitance of single core & 3 core cables, dielectric stress, optimum cable thickness, grading, dielectric loss and loss angle.	5
5	**Performance of lines:** Short, medium (nominal, T) and long lines and their representation. A.B.C.D constants, Voltage regulation, Ferranti effect, Power equations and line compensation, Power Circle diagrams.	6
6	**Tariff:** Guiding principle of Tariff, different types of tariff.	3

Text books:

1. Electrical Power System, Subir Roy, Prentice Hall
2. Power Systems, A. Ambikapathy, Khanna Publishing House
3. Power System Engineering, Nagrath & Kothery, TMH
4. Elements of power system analysis, C.L. Wodhwa, New Age International.
5. Electrical Power System, Ashfaq Hussain, CBS Publishers & Distributors

Reference books

1. Electric Power transmission & Distribution, S.Sivanagaraju, S.Satyanarayana,, Pearson Education.
1. A Text book on Power system Engineering, Soni, Gupta, Bhatnagar & Chakrabarti, Dhanpat Rai & Co.
2. Electric Power distribution system Engineering, 2nd Edition, T. Gonen, CRC Press.
3. www.powermin.nic.in/acts_notification/pdf/ier1956.pdf

Name of the course	CONTROL SYSTEM
Course Code: PC-EE-503	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Course Objective:

1.	To find mathematical representation of LTI systems.
2.	To find time response of LTI systems of different orders
3.	To find the frequency response of LTI systems of different orders
4.	To understand stability of different LTI systems.
5.	To analyze LTI systems with state variables.
6.	To solve problems of mathematical modelling and stability of LTI systems

Pre-Requisite:

1.	Basic Electrical Engineering (ES-EE-101)
2.	Electric Circuit Theory (PC-EE-301)
3.	Electromagnetic field theory (PC-EE-303)
4.	Electric Machine-I (PC-EE-401)

Course Outcomes:

CO1	Identify the basic elements and structures of feedback control systems.
CO2	Demonstrate the mathematical and physical modelling of dynamic systems.
CO3	Determine and analyze the time response and Steady state errors for 1st and 2nd order system with step input.
CO4	Construct the Bode , Nyquist and Root locus plot & determine the stability analysis of linear system from these plot .
CO5	Moderating the Improvement of system performance through Compensator and PID Controller.
CO6	Demonstrate the state variable analysis of continuous control system.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	-	-	2	-	2	1	-	2		3	2	3
CO2	3	3	3	1	3	-	-	-	2	3	2	3		3	3	3
CO3	3	3	2	1	2	2	-	1	2	3	3	3		3	3	2
CO4	3	3	3	3	2	2	-	1	2	3	3	3		3	3	3
CO5	3	2	3	3	3	-	-	1	2	2	3	2		3	3	3
CO6	3	3	2	2	2	-	-	1	2	2	3	3		3	2	2
Avg	3.00	2.50	2.33	1.83	2.40	2.00	2.00	1.00	2.00	2.33	2.80	2.67		3.00	2.67	2.67

Detail Syllabus:

Unit	Content	Hrs
1	**Introduction to control system:** Concept of feedback and Automatic control, Effects of feedback, Objectives of control system, Definition of linear and nonlinear systems, Elementary concepts of sensitivity and robustness. Types of control systems, Servomechanisms and regulators, examples of feedback control systems. Transfer function concept. Pole and Zeroes of a transfer function. Properties of Transfer function.	4
2	**Mathematical modeling of dynamic systems:** Translational systems, Rotational systems, Mechanical coupling, Liquid level systems, Electrical analogy of Spring–Mass-Dashpot system. Block diagram representation of control systems. Block diagram algebra. Signal flow graph. Mason's gain formula. Control system components: Potentiometer, Synchros, Resolvers, Position encoders. DC and AC tacho-generators. Actuators. Block diagram level description of feedback control systems for position control, speed control of DC motors, temperature control, liquid level control, voltage control of an Alternator.	8
3	**Time domain analysis:** Time domain analysis of a standard second order closed loop system. Concept of undamped natural frequency, damping, overshoot, rise time and settling time. Dependence of time domain performance parameters on natural frequency and damping ratio. Step and Impulse response of first and second order systems. Effects of Pole and Zeros on transient response. Stability by pole location. Routh-Hurwitz criteria and applications. ramp and parabolic inputs. Concepts of system types and error constants.	8

4	**Stability Analysis:** Root locus techniques, construction of Root Loci for simple systems. Effects ofgain on the movement of Pole and Zeros. **Frequency domain analysis of linear system:** Bode plots, Polar plots, Nichols chart, Concept ofresonance frequency of peak magnification. Nyquist criteria, measure of relative stability, phase andgain margin. Determination of margins in Bode plot. Nichols chart. M-circle and M-Contours inNichols chart.		10
5	**Control System performance measure:** Improvement of system performance through compensation. Lead, Lag and Lead- lag compensation, PI, PD and PID control.		5
6	**State variable Analysis:** Concepts of state variables. State space model. Diagonalization of State Matrix. Solution of state equations. Eigenvalues and Stability Analysis. Concept of controllability and observability. Pole-placement by state feedback. Discrete-time systems. Difference Equations. State-space models of linear discrete-time systems. Stability of linear discrete-time systems.		10

Text books:

1. Modern Control Engineering, K. Ogata, 4th Edition, Pearson Education
2. Control System Engineering, I. J. Nagrath & M. Gopal. New AgeInternational Publication.
3. Control System Engineering, D. Roy Choudhury, PHI
4. Control System, A. Ambikapathy, Khanna Publishing House
5. Automatic Control Systems, B.C. Kuo & F. Golnaraghi, 8th Edition, PHI

Reference books

1. Control Engineering Theory & Practice, Bandyopadhyaya, PHI
2. Control systems, K.R. Varmah, Mc Graw hill
3. Control System Engineering, Norman Nise, 5th Edition, John Wiley & Sons
4. Modern Control System, R.C. Dorf & R.H. Bishop, 11th Edition, PearsonEducation.

5. Control System Design, C. Goodwin Graham, F. Graebe F. Stefan, Salgado. E. Mario, PHI
6. Modeling & Control of dynamic system, Macia & Thaler, Thompson
7. Modern Control Technology Components & Systems, 3rd edition, C.T Kilian, Cengage Learning
8. Modern Control Engineering, Y. Singh & S. Janardhanan, Cengage Learning
9. Control System Engineering, R. Anandanatarajan& R. Ramesh Babu, ,SCITECH
10. Automatic Control system, A. William, Wolovich, Oxford

Name of the course	POWER ELECTRONICS
Course Code: PC-EE-504	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the functioning and characteristics of power switching devices.
2.	To understand the principle of operation of converters.
3.	To understand different triggering circuits and techniques of commutation of SCR
4.	To find external performance parameter of converters.
5.	To analyze methods of voltage control, improvement of power factor and reduction of harmonics of the converter
6.	To solve numerical problems of converters

Pre-Requisite

1.	Electric Circuit Theory (PC-EE-301)
2.	Analog Electronics (PC-EE-302)
3.	Electromagnetic field theory (PC-EE-303)
4.	Digital Electronics (PC-EE-402)

Course Outcomes:

CO1	Differentiate between signal level and power level devices.
CO2	Construct triggering and commutation circuit of SCR.
CO3	Explain , analyse and solve problem of AC-DC converter.
CO4	Explain , analyse and solve problem of DC-DC converter.
CO5	Explain , analyse and solve problem of DC-AC Converter.
CO6	Apply methods for voltage control and harmonics reduction in Inverter.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	0	1	0	0	0	1	0	0	1	0	2	3	3	2
CO2	3	1	3	0	0	0	0	0	1	0	0	1	1	1	1
CO3	3	3	2	0	1	1	0	0	2	1	0	3	3	3	1
CO4	3	3	2	0	1	1	0	0	2	1	0	3	3	3	2
CO5	3	3	2	0	1	1	0	0	2	1	0	3	3	3	2
CO6	3	1	1	1	2	1	1	0	2	0	0	1	2	2	1
Avg	3.00	2.20	1.83	1.00	1.25	1.00	1.00	0.00	1.80	1.00	0.00	2.17	2.50	2.50	1.50

Detail Syllabus:

Unit	Content	Hrs
1	**Introduction:** Concept of power electronics, application of power electronics, uncontrolled converters,advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT and GTO.	4
2	**PNPN devices:** Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.	5
3	**Phase controlled converters:** Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters	6

4	**DC-DC converters:** Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers.	5
5	**Inverters:** Definition, classification of inverters based on nature of input source, wave shape of outputvoltage, method of commutation & connections. Principle of operation of single phase andthree phase bridge inverter with R and R-L loads, performance parameters of inverters,methods of voltage control and harmonic reduction of inverters.	10
6	**Resonant Pulse Converters:** Introduction, Series Resonant inverter, Parallel Resonant inverter, Zero-Current Switching Resonant converters, Zero-Voltage Switching Resonant converter, Two quadrant Zero-Voltage Switching Resonant converter, Resonant DC link inverter.	5
7	**Applications:** Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS,static VAR controller.	5

Text books:

1. Power Electronics, M.H. Rashid,4th Edition, Pearson
2. Power Electronics, P.S. Bimbhra, Khanna Publishing House.
3. Power Electronics, V.R. Moorthi, Oxford.
4. Power Electronics, M.D. Singh and K.B. Khanchandani, Tata Mc Graw Hill.

Reference books

1. Modern Power Electronics & AC drives, B.K. Bose, Prentice Hall
2. Power Electronics, Mohan,Undeland&Riobbins, Wiley India
3. Element of power Electronics, Phillip T Krein, Oxford.
4. Power Electronics systems, J.P. Agarwal, Pearson Education.
5. Analysis of Thyristor power conditioned motor, S.K. Pillai, University Press.
6. Power Electronics, M.S. Jamal Asgha, PHI.
7. Power Electronics : Principles and applications, J.M. Jacob, Thomson

Name of the course	RENEWABLE & NON CONVENTIONAL ENERGY
Course Code: PE-EE-501C	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Course Objectives:

1.	To understand the difference between Renewable and non-renewable energy sources
2.	To understand methods of conversion of solar energy and wind energy to other form of energy.
3.	To understand methods harnessing energy from Biomass, Geothermal and ocean
4.	To understand the principle of operation of Magneto Hydrodynamic power generation:
5.	To understand the principle and operation of fuel cell.
6.	To solve numerical problems of Renewable and non-renewable energy sources

Pre Requisite:

1.	Electric Circuit Theory (PC-EE-301)
2.	Electromagnetic field theory (PC-EE-303)
3.	Electric Machine-I (PC-EE-401)
4.	Electrical and Electronics measurement (PC-EE-403)

Course Outcomes:

CO1	Able to understand the difference between Renewable and Non-renewable energy sources, prospects of renewable energy generations and their impact on environment
CO2	Able to explain the principal of conversion of Solar energy, Wind energy to other form of energy and calculate the conversion efficiency
CO3	Able to describe the methods of harnessing energy from Biomass, Geothermal, Ocean, Fuel cell
CO4	Able to describe the principle and methods of generation of Magneto Hydrodynamic Power & Hydrogen Energy
CO5	Able to assess the utility of Solar energy, Wind energy, Biomass, Geothermal energy, Ocean energy, Hydrogen energy and the energy from Fuel cell for different Applications
CO6	Able to suggest location to set up Solar, Wind mill, Biogas, Ocean and Geothermal energy generation plant

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	0	0	3	3	1	0	0	0	0	0	3	0
CO2	3	2	1	0	0	3	3	1	0	0	0	0	0	3	0
CO3	3	2	2	2	1	3	3	1	0	0	1	1	1	3	1
CO4	3	2	2	2	1	3	3	1	0	0	1	1	1	3	1
CO5	3	2	2	2	1	3	3	1	0	0	2	1	1	3	1
CO6	3	2	2	2	1	3	3	1	0	0	3	1	1	3	1
Avg	3.00	1.83	1.67	2.00	1.00	3.00	3.00	1.00	0.00	0.00	1.75	1.00	1.00	3.00	1.00

Detail Syllabus:

Unit	Content	Hr
1	**Introduction to Energy sources:** Renewable and non-renewable energy sources, energy consumption as a measure of Nation's development; strategy formeeting the future energy requirements Global and National scenarios, Prospects of renewable energy sources. Impact of renewable energy generation on environment, Kyoto Protocol.	3
2	**Solar Energy:** Solar radiation - beam and diffuse radiation, solar constant, earth sun angles, attenuation and measurement of solarradiation, local solar time, derived solar angles, sunrise, sunset and day length. flat plate collectors, concentratingcollectors, Solar air heaters-types, solar driers, storage of solar energy-thermal storage, solar pond , solar water heaters,solar distillation, solar still, solar cooker, solar heating & cooling of buildings, photo voltaic - solar cells, different typesof PV Cells, Mono-poly Crystalline and amorphous Silicon solar cells. Design of PV array. Efficiency and cost of PVsystems & its applications. PV hybrid systems	8
3	**Wind Energy:** Principle of wind energy conversion; Basic components of wind energy conversion systems; wind mill components, various types and their constructional features; design considerations of horizontal and vertical axis wind machines: analysis ofaerodynamic forces acting on wind mill blades and estimation of power output; wind data and site selection considerations	5

4	**Energy from Biomass:** Biomass conversion technologies, Biogas generation plants, classification, advantages and disadvantages, constructional details, site selection, digester design consideration, filling a digester for starting, maintaining biogas production, Fuel properties of bio gas, utilization of biogas	5
5	**Geothermal Energy:** Estimation and nature of geothermal energy, geothermal sources and resources like hydrothermal, geo-pressured hot dryrock, magma. Advantages, disadvantages and application of geothermal energy, prospects of geothermal energy in India.	5
6	**Energy from Ocean:** Ocean Thermal Electric Conversion (OTEC) systems like open cycle, closed cycle, Hybrid cycle, prospects of OTEC in India. Energy from tides, basic principle of tidal power, single basin and double basin tidal power plants, advantages, limitation and scope of tidal energy. Wave energy and power from wave, wave energy conversion devices, advantages and disadvantages of wave energy.	5
7	**Magneto Hydrodynamic power generation:** Principle of MHD power generation, MHD system, Design problems and developments, gas conductivity, materials for MHD generators and future prospects.	5
8	**Hydrogen Energy:** Introduction, Hydrogen Production methods, Hydrogen storage, hydrogen transportation, utilization of hydrogen gas, hydrogen as alternative fuel for vehicles.	3
9	**Fuel cell:** Introduction, Design principle and operation of fuel cell, Types of fuel cells, conversion efficiency of fuel cell, application of fuel cells	3

Text books:

1. Renewable energy sources and conversion technology, Bansal Keemann, Meliss, Tata Mc Graw Hill.
2. Energy Technology, O.P. Gupta, Khanna Publishing House.
3. Renewable energy resources and emerging technologies, D.P. Kothari, PHI.
4. Non-conventional Energy sources, G.D. Rai, Khanna Publishers.
5. Non Conventional Energy Resources, Chandra, Khanna Publishing House.

Reference books

1. Non-conventional Energy, Ashok V. Desai, New Age International Publishers Ltd.

Name of the course	DATA STRUCTURE & ALGORITHM
Course Code: OE-EE-501A	Semester: 5th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs./week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Practical: hrs./week	Attendance: 05 Marks
Credit Points: 3	End Semester Exam: 70 Marks

Objective:

1.	To understand the basics of abstract data types.
2.	To understand the principles of linear and nonlinear data structures.
3.	To build an application using sorting and searching

Pre-Requisite

1.	Programing for problem solving (ES-CS 201)
2.	Mathematics (BS-M-102)
3.	Mathematics (BS-M-202)

Course Outcomes:

CO1	Differentiate how the choices of data structure & algorithm methods enhance the performance of the program.
CO2	Solve problems based upon different data structure & also write programs.
CO3	Write programs based on different data structure
CO4	Identify appropriate data structure & algorithmic methods in solving problem.
CO5	Discuss the computational efficiency of the principal algorithms for sorting, searching, and hashing
CO6	Compare the benefits of dynamic and static data structures implementations.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	1	1	1	0	2	2	3	2	3	0	2		3	3	3
CO2	3	2	1	1	2	0	0	3	1	1	3	3		2	2	1
CO3	3	2	2	2	1	0	0	2	2	2	2	3		2	1	2
CO4	3	3	3	2	0	0	0	2	3	2	2	2		2	3	3
CO5	3	2	1	1	3	0	0	2	3	1	2	1		3	3	3
CO6	3	2	2	1	0	0	0	2	2	0	2	1		3	2	2
Avg	3.00	2.00	1.67	1.33	2.00	2.00	2.00	2.33	2.17	1.80	2.20	2.00		2.50	2.33	2.33

Detail Syllabus:

Unit	Content	Hrs
1	Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off. Searching: Linear Search and Binary Search Technique sand their complexity analysis.	10
2	Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.	10
3	Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis. Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis	10

4	Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing. Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.	10

Text books:

1. Data Structures and Program Design In C, 2/E by Robert L. Kruse, Bruce P. Leung. PHI
2. Data Structure & Algorithms Using C, R.S. Salaria, 5th Ed., Khanna Publishing House
3. Data Structures in C, Aaron M. Tenenbaum. Pearson.
4. Data Structure, S. Lipschutz.. Mc Graw Hill.

Reference books:

1. Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, MIT press
2. Expert Data Structures with C++, R.B Patel, Khanna Publishing House
3. Fundamentals of Data Structures of C, Ellis Horowitz, SartajSahni, Susan Andersonfreed, MIT press
4. Data Structures Using C, ReemaThareja. Oxford University press
5. Data Structure Using C, 2/e by A.K. Rath, A. K. Jagadev. SCITECH
6. Data Structures through C, YashwantKanetkar, BPB Publications.

Name of the course	**ELECTRIC MACHINE-IILABORATORY**
Course Code: PC-EE 591	Semester: 5th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr/week	Continuous Internal Assessment:40
Tutorial: 0 hr/week	External Assessment: 60
Practical: 2 hrs/week	
Credit Points:1	

Course Outcomes:

CO1	Identify appropriate equipment and instruments for the experiment.
CO2	Test the instrument for application to the experiment.
CO3	Construct circuits with appropriate instruments and safety precautions.
CO4	Validate different characteristics of Induction motor, Induction generator and methods of speed control of Induction motors.
CO5	Validate different characteristics of synchronous Machines and parallel operation of the 3 phase Synchronous generator.
CO6	Work effectively in a team.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	2	1	1	1		1								2		
CO2	1	1	1	1										2		
CO3	2	2	2			1	1				1	1		2		
CO4	2	2	2											1		
CO5	2	2	2	1		1	1							1		
CO6								1	1	1						
Avg	**1.80**	**1.60**	**1.60**	**1.00**	**0.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**		**1.60**	**0.00**	**0.00**

Detail Syllabus:

1.	Different methods of starting of a 3 phase Cage Induction Motor & their comparison [DOL, Auto transformer &Star-Delta]
2.	Study of equivalent circuit of three phase Induction motor by no load and blocked rotor test.
3.	Study of performance of wound rotor Induction motor under load.
4.	Study of performance of three phase squirrel- cage Induction motor –determination of iron-loss, friction &windage loss.
5.	Speed control of 3 phase squirrel cage induction motor by different methods & their comparison [voltage control & frequency control].
6.	Speed control of 3 phase slip ring Induction motor by rotor resistance control
7.	Determination of regulation of Synchronous machine by a. Potier reactance method. b. Synchronous Impedance method.
8.	Determination of equivalent circuit parameters of a single phase Induction motor.
9.	Load test on single phase Induction motor to obtain the performance characteristics.
10.	To determine the direct axis resistance [Xd] & quadrature reactance [Xq] of a 3 phase synchronous machine byslip test.
11.	Load test on wound rotor Induction motor to obtain the performance characteristics.
12.	To make connection diagram to full pitch & fractional slot winding of 18 slot squirrel cage Induction motor for6 poles & 4 pole operation
13.	To study the performance of Induction generator
14.	Parallel operation of 3 phase Synchronous generators
15.	V-curve of Synchronous motor

Text books:

1. Laboratory experiments on Electrical Machines, C.K. Chanda, A. Chakrabarti, Dhanpat Rai & Co.
2. Laboratory manual for Electrical Machines, D.P. Kothari, B.S.Umre, I K International Publishing House Pvt. Ltd.

Name of the course	**POWER SYSTEM-I LABORATORY**
Course Code: PC-EE 592	Semester: 5th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr/week	Continuous Internal Assessment:40
Tutorial: 0 hr/week	External Assessment: 60
Practical: 2 hrs/week	
Credit Points:1	

Course Outcomes:

CO1	Identify appropriate equipment and instruments for the experiment and Work effectively in a team.
CO2	Test the instrument for application to the experiment.
CO3	Construct circuits with appropriate instruments and safety precautions.
CO4	Validate different characteristics of transmission line.
CO5	Determine earth resistance, dielectric strength of insulating oil, breakdown strength of solid insulating material and dielectric constant of transformer oil.
CO6	Analyze an electrical transmission line circuit with the help of software.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1		1							1			1		
CO2	1		1										1		
CO3	2		1								1		1		
CO4	2	2	2										1		
CO5	2	2	2	1									1		
CO6	1	1	1										1		
Avg	1.50	1.67	1.33	1.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00

Detail Syllabus:

1.	Determination of the generalized constants A.B, C, D of long transmission line and regulation of a 3-Φ transmission line model
2.	Study of distribution system by network analyzer.
3.	Measurement of earth resistance by earth tester.

4.	Determination of dielectric strength of insulating oil.
5.	Determination of breakdown strength of solid insulating material
6.	Determination of parameter of 3-Φ transmission line model by power circle diagram
7.	Study of different types of insulator.
8.	Study of active and reactive power control of alternator.
9.	Study and analysis of an electrical transmission line circuit with the help of software
10.	Determination of dielectric constant, tan delta, resistivity of transformer oil.

Name of the course	**CONTROL SYSTEMLABORATORY**
Course Code: PC-EE 593	Semester: 5th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr/week	Continuous Internal Assessment:40
Tutorial: 0 hr/week	External Assessment: 60
Practical: 2 hrs/week	

Course Outcomes:

CO1	Identify appropriate equipment and instruments for the experiment
CO2	Test the instrument for application to the experiment.
CO3	Construct circuits with appropriate instruments and safety precautions.
CO4	Use MAT-Lab control system tool box, MAT-Lab- simulink tool box & PSPICE for simulation of systems.
CO5	Determine control system specifications of first and second order systems.
CO6	Validate step response & impulse response for type-0, type-1 & Type-2 system with unity feedback using MATLAB & PSPICE.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	3	0	1	0	0	0	1	3		2	3	3
CO2	3	3	3	3	3	0	2	0	0	0	1	3		3	3	3
CO3	3	3	3	3	3	1	2	0	0	0	1	3		3	3	3
CO4	3	3	3	3	3	1	2	0	0	0	1	3		3	3	3
CO5	3	3	2	2	1	1	1	0	0	0	1	3		2	3	3
CO6	3	3	3	3	3	1	1	0	0	0	1	3		2	2	3
Avg	3.00	2.83	2.67	2.50	2.67	1.00	1.50	0.00	0.00	0.00	1.00	3.00		2.50	2.83	3.00

Detail Syllabus:

1.	Familiarization with MAT-Lab control system tool box, MAT-Lab-simulink tool box & PSPICE
2.	Determination of Step response for first order & Second order system with unity feedback with the help of CRO &calculation of control system specification , Time constant, % peak overshoot, settling time etc. from theresponse.
3.	Simulation of Step response & Impulse response for type-0, type-1 & Type-2 system with unity feedback usingMATLAB & PSPICE.

4.	Determination of Root locus, Bode plot, Nyquist plot using MATLAB control system tool box for a given system &stability by determining control system specification from the plot.
5.	Determination of PI, PD and PID controller action of first order simulated process.
6.	Determination of approximate transfer functions experimentally from Bode plot.
7.	Evaluation of steady state error, setting time, percentage peak overshoot, gain margin, phase margin with addition of Lead, Lag, Lead-lag compensator.
8.	Study of a practical position control system obtaining closed step responses for gain setting corresponding to over-damped and under-damped responses. Determination of rise time and peak time using individualized components by simulation. Determination of un-damped natural frequency and damping ratio from experimental data.
9.	Analysis of performance of Lead, Lag and Lead-Lag compensation circuits for a given system using simulation.
10.	Determination of Transfer Function of a given system from State Variable model and vice versa.
11.	Analysis of performance of a physical system using State variable technique by simulation. Study of step response and initial condition response for a single input, two-output system in SV form by simulation.

Name of the course	**POWER ELECTRONICS LABORATORY**
Course Code: PC-EE 594	Semester: 5th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr/week	Continuous Internal Assessment:40
Tutorial: 0 hr/week	External Assessment: 60
Practical: 2 hrs/week	
Credit Points:1	

Course Outcomes:

CO1	Demonstrate and analyse SCR & TRIAC characteristics.
CO2	Design and implement different triggering circuits for firing SCRs.
CO3	Design, Simulate and evaluate performance of different controlled rectifiers.
CO4	Design, Simulate and evaluate performance of chopper.
CO5	Design, Simulate and evaluate performance of inverter and PWM generation.
CO6	Demonstrate the charecteristics of Resonant Converter.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	1	0	0	1	0	0	0	2	1	2	1		2	1	0
CO2	3	2	3	1	1	0	0	0	1	0	0	0		2	1	0
CO3	3	3	3	2	3	1	0	0	2	0	1	0		3	3	1
CO4	3	3	3	2	3	1	0	0	2	0	1	1		3	3	1
CO5	3	3	3	2	3	1	0	0	2	0	1	1		3	3	1
CO6	3	1	2	2	3	0	0	0	2	1	0	0		2	3	0
Avg	3.00	2.17	2.80	1.80	2.33	1.00	0.00	0.00	1.83	1.00	1.25	1.00		2.50	2.33	1.00

Detail Syllabus:

1.	Study of the characteristics of an SCR.
2.	Study of the characteristics of a Triac
3.	Study of different triggering circuits of an SCR
4.	Study of firing circuits suitable for triggering SCR in a single phase full controlled bridge.
5.	Study of the operation of a single phase full controlled bridge converter with R and R-L load.

6.	Study of performance of single phase half controlled symmetrical and asymmetrical bridge converters.
7.	Study of performance of step down chopper with R and R-L load.
8.	Study of performance of single phase controlled converter with and without source inductance (simulation)
9.	Study of performance of step up and step down chopper with MOSFET, IGBT and GTO as switch (simulation)
10.	Study of performance of single phase half controlled symmetrical and asymmetrical bridge converter. (simulation)
11.	Study of performance of three phase controlled converter with R & R-L load. (simulation)
12.	Study of performance of PWM bridge inverter using MOSFET as switch with R and R-L load.
13.	Study of Zero Voltage Switching Resonant converter and Zero Current Switching Resonant Converter andto plot its output waveforms.
14.	Study the speed control of universal motor to plot speed v/s α

Name of the course	**POWER SYSTEM-II**
Course Code: PC-EE-601	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand the method of representation of power system components
2.	To know about loacation and components of a distribution substation.
3.	To understand different methods of load flow studies.
4.	To determine faults in Electrical systems.
5.	To understand the principle of power system stability.
6.	To understand the principle of relays and methods of protection of power system
7.	To solve numerical problems on the topics studied.

Pre-Requisite:

1.	Electric Circuit Theory (PC-EE-301)
2.	Electromagnetic field theory (PC-EE-303)
3.	Power system-I (PC-EE-502)

Course Outcomes:

CO1	Identify different types of faults and carry out fault current in each fault [knowledge + application]
CO2	Develop load flow solution for a power system [synthesis]
CO3	Distinguish between different types of relays and develop protection scheme using them [comprehension + synthesis]
CO4	Differentiate different types of circuit breakers and apply them for power system protection [analysis + application]
CO5	Determine the stability of Power system. [analysis]
CO6	Solve numerical problems related to representation, load flow, faults, stability and protection of power system. [analysis + application]

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	3	-	-	3	-	2	-	2	-	-	-	3	-	2
CO2	1	3	3	2	2	-	-	-	-	-	-	-	1	-	1
CO3	2	-	3	1	-	-	-	1	-	-	-	1	2	-	3
CO4	2	-	2	-	-	1	-	1	-	-	-	1	-	1	-
CO5	2	-	3	1	-	-	2	-	-	-	-	2	2	1	3
CO6	-	2	-	1	-	1	-	-	2	-	-	2	1	2	2
Avg	1.80	2.67	2.75	1.25	2.50	1.00	2.00	1.00	2.00	0.00	0.00	1.50	1.80	1.33	2.20

Detail Syllabus:

Unit	Content	Hrs
1	Representation of Power system components: Single-phase representation of balanced three phase networks, the one-line diagram and the impedance or reactance diagram, per unit (PU) system.	2
2	Distribution substation: Types of substations, location of substations, substation equipments and accessories, earthling (system & equipment), feeder and distributors, radial and loop systems.	5
3	Load flow studies: Network model formulation, formation of Y_{bus}, load flow problem, Gauss-Siedel method, Newton-Raphson method, Decoupled load flow studies, comparison of load flow methods.	5
4	Faults in Electrical systems: Transient on a transmission line, short circuit of a synchronous machine under no load & loaded condition. Symmetrical component transformation, sequence impedance and sequence network of power system, synchronous machine, transmission lines and transformers. Symmetrical component analysis of unsymmetrical faults, single line-to –ground fault, lineto- line fault, double line-to-ground fault	8
5	Power system stability: Steady state stability, transient stability, equal area criteria, swing equation, multi machine stability concept	4

| 6 | Power system protection: Protective zones, Relaying elements and quantities. Protective relays, basic requirements and type of protection, phase and amplitude comparator, grading (time & current), classification of Electromagnetic relays, Directional relay, Distant relay, Differential relay, basic aspects of static and digital relays, relay protection scheme for transformer, feeder, generators and motors.

Circuit breakers, circuit breaking transients, transient recovery voltage, current chopping and resistance switching, circuit breaker rating, arc and arc extinction, circuit breaker types, oil circuit breaker, vacuum circuit breaker, air blast circuit breaker, SF6 circuit breaker and operating mechanism, advantages and disadvantages of different types | 12 |

Text books:

1. Modern Power System Analysis, D.P. Kothari & I.J. Nagrath, 4th Edition, Tata McGraw Hill.
2. Electrical Power Systems, Subir Ray, PHI
3. Switchgear protection and power systems, Sunil S Rao, Khanna Publications.
4. A text book on Power System Engineering, M.L.Soni, P.V.Gupta, U.S. Bhatnagar & A. Chakrabarti, Dhanpat Rai & CO.

Reference books:

1. Protection & Switchgear, B. Bhalja, R.P. Maheshwari, N.G.Chothani, Oxford.
2. Power system protection & switchgear, B.Ram & D.N. Vishwakarma, Tata McGraw Hill.
3. Handbook of Electrical Power Distribution, G. Ramamurthy, University Press
4. Electric Power Transmission and Distribution, S. Sivanagaraju, S.Satyanarayana, Pearson Education.
5. Power Systems Stability, Vol. I,II & II, E.W. Kimbark, Wiley.
6. Power Engineering, D.P Kothari & I.J. Nagrath, Tata McGraw Hill.
7. Power Systems Analysis, A. R. Bergen & V. Vittal, Pearson Education.
8. Computer Aided Power systems analysis, Dr. G. Kusic, CEC press.

Name of the course	**MICROPROCESSOR & MICRO CONTROLLER**
Course Code: PC-EE-602	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand the architecture of 8086 microprocessor.
2.	To understand the design aspects of I/O and Memory Interfacing circuits.
3.	To interface microprocessors with supporting chips.
4.	To understand the architecture of 8051 microcontroller.
5.	To design a microcontroller based system

Pre-Requisite:

1.	Analog Electronics (PC-EE-302)
2.	Digital Electronics (PC-EE-402)

Course Outcomes:

CO1	Illustrate the architecture of 8086 Microprocessor
CO2	Understand different instruction set of 8086 with suitable example program
CO3	Interface different peripheral devices with 8086 Microprocessor
CO4	Explain the architecture and Instruction set of 8051 Micrcontroller
CO5	Demonstrate the interfacing of peripheral deices with 8051 Microcontroller
CO6	Develop Microprocessor and Micro Controller based systems

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	0	1	1	0	0	1	0	0	0	0	1	1	1	2
CO2	3	2	2	0	0	1	0	0	1	0	1	1	2	1	3
CO3	3	3	3	1	3	2	1	0	2	2	1	2	3	3	3
CO4	3	0	1	0	0	0	0	0	1	1	0	1	1	3	2
CO5	3	2	3	1	3	1	1	0	2	2	1	2	3	3	3
CO6	3	3	3	3	3	2	3	0	3	2	3	3	3	3	3
Avg	3.00	2.50	2.17	1.50	3.00	1.50	1.50	0.00	1.80	1.75	1.50	1.67	2.17	2.33	2.67

Detail Syllabus:

Unit	Content	Hrs
1	The 8086 Microprocessor: Introduction to 8086-Microprocessor architecture – Addressing modes – Instruction set and assembler directives – Assembly language programming – Modular Programming – Linking and Relocation – Stacks – Procedures – Macros – Interrupts and interrupt service routines – Byte and String Manipulation.	8
2	8086 System bus structure: 8086 signals – Basic configurations – System bus timing –System design using 8086 – I/O programming – Introduction to Multiprogramming – System Bus Structure – Multiprocessor configurations – Coprocessor, Closely coupled and loosely Coupled configurations – Introduction to advanced processors.	8
3	I/O INTERFACING: Memory Interfacing and I/O interfacing – Parallel communication interface – Serial communication interface – D/A and A/D Interface – Timer – Keyboard /display controller – Interrupt controller –DMA controller – Programming and applications Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.	8
4	Microcontroller: Architecture of 8051 – Special Function Registers (SFRs) – I/O Pins Ports and Circuits – Instruction set – Addressing modes – Assembly language programming.	8

5	Interfacing Microcontroller: Programming 8051 Timers – Serial Port Programming – Interrupts Programming – LCD & Keyboard Interfacing – ADC, DAC & Sensor Interfacing – External Memory Interface- Stepper Motor and Waveform generation – Comparison of Microprocessor, Microcontroller, PIC and ARM processors	6

Text books:

1. Advanced Microprocessors and Peripheral, Koshor M Bhurchandi, Ajay Kumar Ray, 3rd Edition, MC Graw hill education.
2. Microprocessor & Interfacing, D.V. Hall, Mc Graw Hill.
3. The 8051 microcontroller, Ayala, Thomson.

Reference books:

1. Advanced Microprocessors, Y. Rajasree, New Age international Publishers.
2. An introduction to the Intel family of Microprocessors, James L. Antonakos, Pearson Education,
3. The 8051 Microcontroller and Embedded systems, Muhammad Ali Mazidi & J. G. Mazidi, Pearson Education.
4. The 8086 Microprocessors: Programming & Interfacing the PC, K.J.Ayala, Thomson.
5. Microprocessor & Peripherals, S.P. Chowdhury & S. Chowdhury, Scitech.
6. Microchip technology data sheet, www.microchip.comerence books

Name of the course	**DIGITAL CONTROL SYSTEM**
Course Code: PE-EE-601A	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand the principle of sampling and reconstruction of signals.
2.	To find Z-tranaform and inverse Z-transform of systems.
3.	To carry out the analysis and design of digital control systems
4.	To design compensators for digital control system to achieve desired specifications.
5.	To represent digital control systems using state space models.
6.	To analyze the effect sampling on stability, controllability and observability.
7.	To design digital controllers for industrial applications.
8.	To solve numerical problems on the topics studied.

Pre-Requisite:

1.	Control system (PC-EE-503)

Course Outcomes:

CO1	To understand the principle of sampling and reconstruction of signals.
CO2	To find Z-transform and inverse Z-transform of systems.
CO3	To carry out the analysis and design of digital control systems.
CO4	To design compensators for digital control system to achieve desired specifications.
CO5	To represent digital control systems using state space models.
CO6	analyze the effect sampling on stability, controllability, and observability.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	2	-	2	1	2	2	3	2	3
CO2	3	3	3	3	3	1	2	-	2	3	2	3	3	2	3
CO3	3	3	3	3	2	2	2	1	2	3	3	3	3	3	2
CO4	3	3	3	3	2	2	2	1	2	3	3	3	3	3	3
CO5	3	2	3	3	3	1	1	1	2	2	3	2	3	3	3
CO6	3	3	2	2	2	1	-	1	2	2	3	3	3	2	2
Avg	3.00	2.67	2.50	2.50	2.40	1.40	1.80	1.00	2.00	2.33	2.67	2.67	3.00	2.50	2.67

Detail Syllabus:

Unit	Conte	Hrs
1	Sampling and reconstruction: Introduction, Examples of Data control systems – Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.	3
2	Z-transform: Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, the inverse Z – transforms, Modified Z- Transforms	5
3	Z- Plane analysis of discrete-time control system: Z-Transform method for solving difference equations; Pulse transforms function, block diagram analysis of sampled – data systems, mapping between s-plane and z-plane.	5
4	State space analysis: State Space Representation of discrete time systems, Pulse Transfer Function Matrix solving discrete time state space equations, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, Discretization of continuous time state – space equations.	6
5	Controllability and observability: Concepts of Controllability and Observability, Tests for controllability and Observability. Duality between Controllability and Observability, Controllability and Observability conditions for Pulse Transfer Function	4

6	Stabilty analysis: Mapping between the S-Plane and the Z-Plane – Primary strips and Complementary Strips – Constant frequency loci, Constant damping ratio loci, Stability Analysis of closed loop systems in the Z-Plane. Jury stablility test – Stability Analysis by use of the Bilinear Transformation and Routh Stability criterion.	5
7	Design of discrete time control system by conventional methods: Transient and steady – State response Analysis – Design based on the frequency response method – Bilinear Transformation and Design procedure in the w-plane, Lead, Lag and Lead-Lag compensators and digital PID controllers.	6
8	State feedback controllers and observers: Design of state feedback controller through pole placement – Necessary and sufficient conditions, Ackerman's formula. State Observers – Full order and Reduced order observers.	5

Text books:

1. Digital Control and State Variable Methods , M. Gopal, TMH Publishers
2. Discrete-time Control Systems, K. Ogata, Pearson Education,
3. Digital Control Systems, B.C. Kuo, Wiley Publications.
4. Control System Engineering, I.J. Nagrath, M. Gopal, New age International.

Reference books:

1. Digital control of dynamic systems, Gene F. Franklin, J. David Powell, and Michael Workman 3rd ed, 1998, Addison-Wesley.
2. Digital Control Systems, design, identification and implementation, Landau, Ioan Doré, Zito, Gianluca, Springer-Verlag London.

Name of the course	**ELECTRICAL AND HYBRID VEHICLE**
Course Code: PE-EE-602A	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand the basic difference between conventional and Hybrid vehicles.
2.	To understand different configuration and control of Electric drives.
3.	To understand energy storage system in Hybrid vehicles.
4.	To understand different energy management strategies of Hybrid vehicles.
5.	To solve numerical problems on the topics studied

Pre-Requisite:

1.	Electric Machine-I (PC-EE-401)
2.	Electric Machine-II (PC-EE-501)

Course Outcomes:

CO1	Explain the principle of Electric traction.
CO2	Choose a suitable drive scheme for developing an electric hybrid vehicle depending on resources.
CO3	Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
CO4	Choose proper energy storage systems for vehicle applications
CO5	Implement different energy management strategies for hybrid vehicle.
CO6	Design a hybrid electric vehicle (HEV) and battery electric vehicle (BEV)

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	3	1	0	0	0	1	0	0	0	0	0		0	0	1
CO2	3	3	1	1	2	1	0	0	3	0	0	0		0	0	2
CO3	3	3	1	0	2	0	0	0	3	1	2	3		3	0	2
CO4	3	2	2	1	2	0	0	0	3	0	0	3		1	3	1
CO5	3	2	2	1	2	0	0	0	3	2	2	3		3	2	2
CO6	3	2	3	3	3	2	1	1	3	3	3	3		3	3	3
Avg	3.00	2.50	1.67	1.50	2.20	1.50	1.00	1.00	3.00	2.00	2.33	3.00		2.50	2.67	1.83

Detail Syllabus:

Unit	Content	Hrs
1	Introduction: Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.\n\nIntroduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies.\n\nHybrid Electric Drive-trains: Basic concept of hybrid traction,\n\nintroduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.	9
2	Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.\n\nElectric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	10

3	Energy Storage: Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems	9
4	Energy Management Strategies: Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.	6
5	Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).	5

Text books:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Hussein, CRC Press.
2. Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, C. Mi, M. A. Masrur and D. W. Gao, John Wiley & Sons.
3. Electric and Hybrid Vehicles: Khanna Publishing House.
4. Hybrid Electric Vehicles: Energy Management Strategies, Onori Simona, Serrao Lorenzo and Rizzoni Giorgio, Springer.
5. Electric and Hybrid Vehicles, T. Denton, Routledge.

Reference books:

1. Electric Vehicle Technology Explained, James Larminie, John Lowry, Wiley.
2. Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi CRC Press, 2004.

Name of the course	**DIGITAL SIGNAL PROCESSING**
Course Code: OE-EE-601A	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand sampling and reconstruction of signal
2.	To understand the method of Z-transform and inverse Z transform of signal and its properties
3.	To understand Discrete Fourier Transform
4.	To understand methods of design of Digital filters
5.	To understand applications of Digital signal processing
6.	To solve numerical problems on the topics studied

Pre-Requisite:

1.	Electric circuit theory (PC-EE-301)
2.	Control system (PC-EE-503)

Course Outcomes:

CO1	Able to interpret about the Discrete time signals, Digital Systems and their different methods of processing
CO2	Able to compute mathematical operations like convolution, correlations of discrete time sequences.
CO3	Able to execute the Z-transforms and inverse Z- transformation for discrete time signals and the Transfer functions of the digital systems.
CO4	Ability to apply different frequency domain analysis; Discrete Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT) for processing of discrete time signals.
CO5	Able to design analytically Digital IIR and FIR filters using various techniques
CO6	Able to apply Digital Signal Processing for the analysis of real-life signal

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	1	0	0	0	0	0	0	0		0	0	0
CO2	3	3	3	2	1	0	0	0	0	0	0	0		1	0	1
CO3	3	3	3	3	1	0	0	0	0	0	0	0		1	0	1
CO4	3	3	3	3	1	1	0	0	0	0	0	0		1	0	1
CO5	3	3	3	3	2	1	0	0	0	0	0	0		1	0	1
CO6	3	3	3	3	3	2	0	0	0	0	0	0		1	0	2
Avg	3.00	2.83	2.83	2.50	1.50	1.33	0.00	0.00	0.00	0.00	0.00	0.00		1.00	0.00	1.20

Detail Syllabus:

Unit	Content	Hrs
1	Discrete-time signals and systems: Discrete time signals and systems: Sequences; representation of signals on orthogonal basis; Representation of discrete systems using difference equations, Sampling and reconstruction of signals - aliasing; Sampling theorem and Nyquist rate.	6
2	Z-transform: z-Transform, Region of convergence, Analysis of Linear Shift Invariant systems using z-transform, Properties of z-transform for causal signals, Interpretation of stability in z-domain, Inverse z- transforms.	6
3	Discrete Fourier Transform : Frequency Domain Analysis, Discrete Fourier Transform (DFT), Properties of DFT, Convolution of signals, Fast Fourier Transform Algorithm, Parseval's Identity, Implementation of Discrete Time Systems.	8
4	Design of Digital filters: Design of FIR Digital filters: Window method, Park-McClellan's method. Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low-pass, Band-pass, Bandstop and High-pass filters. Effect of finite register length in FIR filter design. Parametric and non-parametric spectral estimation. Introduction to multi-rate signal processing	12
5	Applications of Digital Signal Processing: Correlation Functions and Power Spectra, Stationary Processes, Optimal filtering using ARMA Model, Linear Mean-Square Estimation, Wiener Filter.	6

Text books:

1. Digital Signal Processing-A computer based approach, S. Mitra, TMH
2. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis & M.G. Manslakis, PHI
3. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.

Reference books:

1. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Learning
2. Digital Signal Processing, Chen, OUP
3. Digital Signal Processing, Johnson, PHI
4. Digital Signal Processing using MATLAB, Ingle, Vikas.
5. Digital Signal Processing, Ifeachor, Pearson Education.
6. Digital Signal Processing, A.V. Oppenhein & R.W. Shaffer, PHI
7. Theory and application of Digital Signal Processing, L.R. Rabiner & B. Gold, PHI
8. Digital Signal Processing, Ashok Ambarder, Cengage Learning.
9. Digital Signal Processing, S. Salivahanan, A. Vallavaris & C. Gnanpruja, TMH.
10. Xilinx FPGA user manual and application notes.

Name of the course	**ECONOMICS FOR ENGINEERS**
Course Code: HM-EE-601	Semester: 6th
Duration: 6 months	Maximum Marks: 100
Teaching Scheme	Examination Scheme
Theory: 3 hrs/week	Mid Semester Exam: 15 Marks
Tutorial: 0 hr/week	Assignment & Quiz: 10 Marks
Credit Points: 3	Attendance: 05 Marks
	End Semester Exam: 70 Marks

Objective:

1.	To understand the process of economic decision making
2.	To understand the basic financial management aspects
3.	To develop the skills to analyze financial statements
4.	To understand the basic of accounting

Pre-Requisite:

1.	Basic understanding of Engineering processes

Course Outcomes:

CO1	Evaluate the economic theories, cost concepts and pricing policies
CO2	Explain the market structures and integration concepts
CO3	Apply the concepts of financial management for project appraisal
CO4	Explain accounting systems , the impact of inflation, taxation, depreciation
CO5	Analyze financial statements using ratio analysis
CO6	Explain financial planning, economic basis for replacement, project scheduling, legal and regulatory issues applied to economic investment and project-management problems

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	2	-	2	1	2	2		3	2	3
CO2	3	3	3	3	3	1	2	-	2	3	2	3		3	2	3
CO3	3	3	3	3	2	2	2	1	2	3	3	3		3	3	2
CO4	3	3	3	3	2	2	2	1	2	3	3	3		3	3	3
CO5	3	2	3	3	3	1	1	1	2	2	3	2		3	3	3
CO6	3	3	2	2	2	1	-	1	2	2	3	3		3	2	2
Avg	3.00	2.67	2.50	2.50	2.40	1.40	1.80	1.00	2.00	2.33	2.67	2.67		3.00	2.50	2.67

Detail Syllabus:

Unit	Content	Hrs
1	Economic Decisions Making – Overview, Problems, Role, Decision making process. Engineering Costs & Estimation – Fixed, Variable, Marginal & Average Costs, Sunk Costs, Opportunity Costs, Recurring And Nonrecurring Costs, Incremental Costs, Cash Costs vs Book Costs, Life-Cycle Costs; Types Of Estimate, Estimating Models – Per Unit Model, Segmenting Model, Cost Indexes, Power-Sizing Model, Improvement & Learning Curve, Benefits.	6
2	Cash Flow, Interest and Equivalence: Cash Flow – Diagrams, Categories & Computation, Time Value Of Money, Debt repayment, Nominal & Effective Interest. Present Worth Analysis : End-Of-Year Convention, Viewpoint of Economic Analysis Studies, Borrowed Money Viewpoint, Effect Of Inflation & Deflation, Taxes, Economic Criteria, Applying Present Worth Techniques, Multiple Alternatives. Cash Flow & Rate of Return Analysis – Calculations, Treatment of Salvage Value, Annual Cash Flow Analysis, Analysis Periods; Internal Rate Of Return, Calculating Rate Of Return, Incremental Analysis; Best Alternative Choosing An Analysis Method, Future Worth Analysis, Benefit-Cost Ratio Analysis, Sensitivity And Breakeven Analysis. Economic Analysis In The Public Sector - Quantifying And Valuing Benefits & drawbacks.	10

3	Uncertainty In Future Events - Estimates And Their Use In Economic Analysis, Range Of Estimates, Probability, Joint Probability Distributions, Expected Value, Economic Decision Trees, Risk, Risk vs Return, Simulation, Real Options. Depreciation - Basic Aspects, Deterioration & Obsolescence, Depreciation And Expenses, Types Of Property, Depreciation Calculation Fundamentals, Depreciation And Capital Allowance Methods, Straight-Line Depreciation Declining Balance Depreciation, Common Elements Of Tax Regulations For Depreciation And Capital Allowances.	10
4	Replacement Analysis - Replacement Analysis Decision Map, Minimum Cost Life Of A New Asset, Marginal Cost, Minimum Cost Life Problems. Inflation And Price Change – Definition, Effects, Causes, Price Change With Indexes, Types of Index, Composite vs Commodity Indexes, Use of Price Indexes In Engineering Economic Analysis, Cash Flows that inflate at different Rates.	8
5	Accounting – Function, Balance Sheet, Income Statement, Financial Ratios Capital Transactions, Cost Accounting, Direct and Indirect Costs, Indirect Cost Allocation.	6

Text book:

1. Sociology & Economics for Engineers, Premvir Kapoor, Khanna Publishing House.
2. Engineering Economics, James L.Riggs, David D. Bedworth, Sabah U. Randhawa 4e , McGraw- Hill Education.
3. Engineering Economics Analysis, Donald Newnan, Ted Eschembach, Jerome Lavelle , OUP
4. Principle of Engineering Economic Analysis, John A. White, Kenneth E.Case,David B.Pratt , Wiley

Reference books

1. Engineering Economy, Sullivan and Wicks, Koelling, Pearson
2. Engineering Economics, R. Paneer Seelvan, PHI
3. Engineering Economics Analysis, Michael R Lindeburg, Professional Pub

Name of the course	**POWER SYSTEM-II LABORATORY**
Course Code: PC-EE 691	Semester: 6th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr/week	Continuous Internal Assessment:40
Tutorial: 0 hr/week	External Assessment: 60
Practical: 2 hrs/week	
Credit Points:1	

Course Outcomes:

CO1	Identify appropriate equipment and instruments for the experiment.
CO2	Test the instrument for application to the experiment.
CO3	Construct circuits with appropriate instruments and safety precautions.
CO4	Validate the characteristics of under voltage relay, over current relay, earth fault relay, on load time delay relay, off load time delay relay, CT and PT.
CO5	Validate protection schemes of transformer, generator, motor and feeder.
CO6	Apply software tools to find bus voltage, currents and power flows throughout the electrical system.

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	2	1	-	-	-	-	-	-	-	-	1	-	-
CO2	1	1	3	1	2	-	-	-	-	-	-	1	3	-	2
CO3	2	3	3	3	1	-	-	-	-	-	-	-	-	-	2
CO4	-	2	2	2	2	-	-	-	-	-	-	2	2	2	-
CO5	3	2		1	2	-	-	-	-	-	-	1	2	2	3
CO6	-	-	1	-	3	-	-	-	3	-	-	2	1	2	2
Avg	**2.00**	**2.00**	**2.20**	**1.60**	**2.00**	**0.00**	**0.00**	**0.00**	**3.00**	**0.00**	**0.00**	**1.50**	**1.80**	**2.00**	**2.25**

Detail Syllabus:

1. Study on the characteristics of on load time delay relay and off load time delay relay.
2. Test to find out polarity, ratio and magnetization characteristics of CT and PT.
3. Test to find out characteristics of
   a. under voltage relay
   b. earth fault relay.
4. Study on DC load flow

5.   Study on AC load flow using Gauss-seidel method
6.   Study on AC load flow using Newton Raphson method.
7.   Study on Economic load dispatch.
8.   Study of different transformer protection schemes by simulation
9.   Study of different generator protection schemes by simulation
10.   Study of different motor protection schemes by simulation
11.   Study of different characteristics of over current relay.
12.   Study of different protection scheme for feeder.

Name of the course	**MICRO PROCESSOR AND MICRO CONTROLLER LABORATORY**
Course Code: PC-EE 692	Semester: 6th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 0 hr / week	Continuous Internal Assessment:40
Tutorial: 0 hr / week	External Assessment: 60
Practical: 2 hrs / week	
Credit Points:1	

Course Outcomes:

CO1	Identify appropriate equipment and instruments for the experiment
CO2	Test the instrument for application to the experiment
CO3	Construct circuits with appropriate instruments and safety precautions
CO4	Program 8086 for arithmatic operation, sorting of array, searching for a number in a string and string manipulation
CO5	Interface ADC/DAC, 8255, 8251 to 8086 and LCD, keyboard to 8051
CO6	Program 8051 using arithmatic, logical and bit manipulation instructions of 8051

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	1	0	0	1	0	0	0	1	1	1	0		1	1	0
CO2	3	2	2	1	1	0	0	0	1	0	0	0		1	1	0
CO3	3	3	3	2	2	1	0	0	1	0	0	0		3	3	1
CO4	3	3	3	2	3	1	0	0	2	0	1	1		3	3	3
CO5	3	3	3	2	3	1	1	0	2	0	1	1		3	2	3
CO6	3	3	3	2	3	0	1	0	2	1	0	0		2	2	3
Avg	**3.00**	**2.50**	**2.80**	**1.80**	**2.17**	**1.00**	**1.00**	**0.00**	**1.50**	**1.00**	**1.00**	**1.00**		**2.17**	**2.00**	**2.50**

Detail Syllabus:

1.	Programs for 16 bit arithmetic operations for 8086 (using various addressing modes)
2.	Program for sorting an array for 8086
3.	Program for searching for a number or character in a string for 8086
4.	Program for String manipulations for 8086
5.	Program for digital clock design using 8086.

6.	Interfacing ADC and DAC to 8086.
7.	Parallel communication between two microprocessors using 8255.
8.	Serial communication between two microprocessor kits using 8251.
9.	Interfacing to 8086 and programming to control stepper motor.
10.	Programming using arithmetic, logical and bit manipulation instructions of 8051
11.	Program and verify Timer/Counter in 8051.

Name of the course	**ELECTRICAL AND ELECTRONICS DESIGN LABORATORY**
Course Code: PC-EE 681	Semester: 6th
Duration: 6 months	Maximum marks:100
Teaching Scheme	Examination scheme:
Theory: 1hr / week	Continuous Internal Assessment:40
Tutorial: 0 hr / week	External Assessment: 60
Practical: 4 hrs / week	
Credit Points:3	

Course Outcomes:

CO1	explain basic concept of measurement, noise in electronic system, sensor and signal conditioning circuits
CO2	Implement PC based data acquisition systems
CO3	Construct circuits with appropriate instruments and safety precautions
CO4	Design heating elements, air core grounding reactor, power distribution system for small township, double circuit transmission line and Electric machines
CO5	Do wiring and installation design of a multistoried residential building with lift and pump
CO6	Design electronic hardware for controller of lift, speed of AC/DC motor, and for an application with analog, digital, mixed signal, microcontroller and PCB

Mapping with CO – PO – PSO

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12		PSO 1	PSO 2	PSO 3
CO1	3	3	1	0	0	0	1	0	0	0	0	0		0	0	1
CO2	3	3	1	1	2	1	0	0	3	0	0	0		0	0	2
CO3	3	3	1	0	2	0	0	0	3	1	2	3		3	0	2
CO4	3	2	2	1	2	0	0	0	3	0	0	3		1	3	1
CO5	3	2	2	1	2	0	0	0	3	2	2	3		3	2	2
CO6	3	2	3	3	3	2	1	1	3	3	3	3		3	3	3
Avg	**3.00**	**2.50**	**1.67**	**1.50**	**2.20**	**1.50**	**1.00**	**1.00**	**3.00**	**2.00**	**2.33**	**3.00**		**2.50**	**2.67**	**1.83**

Detail Syllabus:

GROUP A	
1.	Designing a heating element with specified wattage, voltage and ambient temperature.

2.	Designing an air core grounding reactor with specified operating voltage, nominal current and fault current
3.	Designing the power distribution system for a small township
4.	Designing a double circuit transmission line for a given voltage level and power (MVA) transfer.
5.	Wiring and installation design of a multistoried residential building (G+4,not less than 16 dwelling flats with a lift and common pump)
GROUP B	
6.	Designing an ONAN distribution transformer.
7.	Designing a three phase squirrel cage induction motor.
8.	Designing a three phase wound rotor induction motor.
9.	Designing a split phase squirrel cage induction motor for a ceiling fan or a domestic pump.
10.	Designing a permanent magnet fractional hp servo motor.
GROUP C	
11.	Design the control circuit of a Lift mechanism
12.	Design a controller for speed control of DC machine.
13.	Design a controller for speed control of AC machine.
14.	Electronic system design employing electronic hardware (Analog, Digital, Mixed signal), microcontrollers, CPLDs, and FPGAs, PCB design and layout leading to implementation of an application.

Topics to be covered in the Lecture class:

1	Basic concepts on measurements; Noise in electronic systems; Sensors and signal conditioning circuits; Introduction to electronic instrumentation and PC based data acquisition; Electronic system design, Analog system design, Interfacing of analog and digital systems, Embedded systems,; System assembly considerations.

Evaluation Method:

1. The students would INDIVIDUALLY design the equipment and systems as per specifications provided by the class teacher following established procedures.
2. For each student, one item from each of the three groups would be chosen.
3. For unspecified items of specification and or specifications of wires, cables etc., data should be taken by students from handbooks and Indian standard.
4. Students should spend the allotted periods for carrying out design computations.
5. Their attendance shall be recorded.
6. Students should maintain a dedicated bound notebook for recording design activities like calculations, formulae used, sketches, flowcharts etc. The notebook should be regularly submitted to the class teacher for review and signature.
7. Evaluation would be based on (i) Class attendance (20%), (ii) Design Note Book (30%) (iii) Design
8. Report (30%) (iv) End of semester viva (20%)