Fundamentals of Electrical & Electronics Engineering

(with Lab Manual)

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Saji T. Chacko

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FOREWORD

Engineering has played a very significant role in the progress and expansion of mankind and society for centuries. Engineering ideas that originated in the Indian subcontinent have had a thoughtful impact on the world.

All India Council for Technical Education (AICTE) had always been at the forefront of assisting Technical students in every possible manner since its inception in 1987. The goal of AICTE has been to promote quality Technical Education and thereby take the industry to a greater heights and ultimately turn our dear motherland India into a Modern Developed Nation. It will not be inept to mention here that Engineers are the backbone of the modern society - better the engineers, better the industry, and better the industry, better the country.

NEP 2020 envisages education in regional languages to all, thereby ensuring that each and every student becomes capable and competent enough and is in a position to contribute towards the national growth and development.

One of the spheres where AICTE had been relentlessly working from last few years was to provide high-quality moderately priced books of International standard prepared in various regional languages to all it's Engineering students. These books are not only prepared keeping in mind it's easy language, real life examples, rich contents and but also the industry needs in this everyday changing world. These books are as per AICTE Model Curriculum of Engineering & Technology – 2018.

Eminent Professors from all over India with great knowledge and experience have written these books for the benefit of academic fraternity. AICTE is confident that these books with their rich contents will help technical students master the subjects with greater ease and quality.

AICTE appreciates the hard work of the original authors, coordinators and the translators for their endeavour in making these Engineering subjects more lucid.

(**Anil D. Sahasrabudhe**)

Acknowledgement

The author(s) are grateful to AICTE for their meticulous planning and execution to publish the technical book for Diploma students.

We sincerely acknowledge the valuable contributions of the reviewer of the book Prof. Akole Kishor Pralhad, for making it students' friendly and giving a better shape in an artistic manner.

This book is an outcome of various suggestions of AICTE members, experts and authors who shared their opinion and thoughts to further develop the engineering education in our country.

It is also with great honour that we state that this book is aligned to the AICTE Model Curriculum and in line with the guidelines of National Education Policy (NEP) -2020. Towards promoting education in regional languages, this book is being translated in scheduled Indian regional languages.

Acknowledgements are due to the contributors and different workers in this field whose published books, review articles, papers, photographs, footnotes, references and other valuable information enriched us at the time of writing the book.

Finally, we like to express our sincere thanks to the publishing house, M/s. Khanna Book Publishing Company Private Limited, New Delhi, whose entire team was always ready to cooperate on all the aspects of publishing to make it a wonderful experience.

Susan S. Mathew &
Saji T. Chacko

Preface

The book entitled "Fundamentals of Electrical and Electronics Engineering" is an outcome of the rich experience of our teaching of Basic Electrical and Electronics Engineering courses. The initiation of writing this book is to expose to the students of polytechnic, the fundamentals of Electrical and Electronics Engineering as well as enable them to get an insight of the course and develop related practical outcomes. Keeping in mind the purpose of wide coverage as well as to provide essential supplementary information, we have included the topics recommended by AICTE, in a very systematic and orderly manner throughout the book. Efforts have been made to explain the fundamental concepts of the course in the simplest possible way.

During the process of preparation of the manuscript, we have considered the various standard text books and accordingly we have developed sections like critical questions, solved and supplementary problems etc. While preparing the different sections emphasis has also been laid on definitions and laws and also on comprehensive synopsis of formulae for a quick revision of the basic principles. The book covers all types of medium and advanced level problems and these have been presented in a very logical and systematic manner. The gradations of those problems have been tested over many years of teaching a wide variety of students.

Apart from illustrations and examples as required, we have enriched the book with numerous solved problems in every unit for proper understanding of the related topics. It is important to note that in all the books, we have included the relevant laboratory practical. In addition, besides some essential information for the users under the heading "Know More" we have clarified some essential basic information in the appendix and annexure section.

As far as the present book is concerned, "Fundamentals of Electrical and Electronics Engineering " is meant to prepare students to apply the knowledge of to tackle the challenges and address the related aroused questions that students and diploma holders will face ahead. The course contents are presented in a constructive manner so that an Engineering diploma will prepare the students to work in different sectors.

We sincerely hope that the book will inspire the students to understand the concepts and will surely contribute to the development of a solid foundation of the course. Although all care has been taken to check for mistakes and misprints in this text book and laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors, mistakes, omissions, suggestions for improvement are highly welcome and can be brought to our notice, which will contribute to the improvement of the future editions of the book.

It was indeed a big pleasure to work on different aspects culminating in the form of this book and we do hope that it will be helpful to understand the basic concepts of the vast and interesting field of Electrical and Electronics Engineering and will be a useful learning aid to develop the expected learning outcomes.

Susan S. Mathew
Saji T. Chacko

Outcome Based Education

Outcome based education comprises of outcome based curriculum, outcome based teaching-learning process and outcome based assessment to achieve targeted learning outcomes. As per National Board of Accreditation, after completion of diploma program in engineering and technology the graduate will be able to:

PO1. **Basic and Discipline specific knowledge:** Apply knowledge of basic mathematics, science and engineering fundamentals and engineering specialization to solve the engineering problems.

PO2. **Problem analysis:** Identify and analyse well-defined engineering problems using codified standard methods.

PO3. **Design/ development of solutions:** Design solutions for well-defined technical problems and assist with the design of sys tems components or processes to meet specified needs.

PO4. **Engineering Tools, Experimentation and Testing:** Apply modern engineering tools and appropriate technique to conduct standard tests and measurements.

PO5. **Engineering practices for society, sustainability and environment:** Apply appropriate technology in context of society, sustainability, environment and ethical practices.

PO6. **Project Management:** Use engineering management principles individually, as a team member or a leader to manage projects and effectively communicate about well-defined engineering activities.

PO7. **Life-long learning:** Ability to analyse individual needs and engage in updating in the context of tecnological changes

Course Outcomes

After completion of the course the students will be able to:

CO-1: Suggest electrical/electronic component for given engineering application.

CO-2: Test basic analogue circuits consist of OP-AMP.

CO-3: Interpret the working of the digital circuits.

CO-4: Use principles of electric and magnetic circuits in engineering applications.

CO-5: Interpret the working of the A.C. circuits.

CO-6: Operate transformers and electric motors for specific requirements safely.

Course Outcomes	Expected Mapping with Programme Outcomes (1- Weak Correlation; 2- Medium correlation; 3- Strong Correlation)						
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7
CO-1	3	2	2	3	1	1	1
CO-2	3	1	1	2	1	1	1
CO-3	3	1	1	-	1	1	1
CO-4	3	2	1	1	1	1	1
CO-5	3	2	1	2	1	1	1
CO-6	3	2	1	2	1	1	1

Abbreviations and Symbols

List of Abbreviations

Abbreviation	Fullform	Abbreviation	Fullform
A_{cm}	Common mode gain	JFET	Junction Field Effect transistor
A_d	Differential mode gain	KCL	Kirchhoff's Current Law
AC	Alternating Current	KVL	Kirchhoff's Voltage Law
B	Magnetic flux density	LED	Light Emitting Diode
BJT	Bipolar Junction Transistor	LSB	Least Significant Bit
BW	Band Width	LV	Low Voltage
C	Coulomb	M	Mutual Inductance
CMOS	Complementary Metal Oxide Semiconductor	MOSFET	Metal Oxide Field Effect Transistor
CB	Common Base	MSB	Most Significant Bit
CC	Common Collector	OL	Open loop
CE	Common Emitter	OP-Amp	Operational Amplifier
CL	Closed loop	P	Power
CMRR	Common Mode Rejection Ratio	PIV	Peak Inverse Voltage
CO	Course Outcome	PO	Program Outcome
DC/ D.C./dc	Direct Current	PSRR	Power Supply Rejection Ratio
AC/ A.C./ac	Alternating Current	PVC	Poly Vinyl Chloride
emf	electro motive force	Q	Quality factor
FB	Forward Biased	R, L, C	Resistor, Inductor, Capacitor
FF	FlipFlop	RF	DC or static resistance
G	Conductance	RMS	Root Mean Square Value
Ge	Germanium	S, R	Set, Reset
H	Magnetic field intensity	Si	Silicon
HV	High Voltage	T	Time period
Hz	Hertz	t	Time
I	Current	TTL	Transistor Transistor Logic
i	Instantaneous value of current	UO	Unit Outcome

I_B	Base current	V	Voltage
IC	Integrated Circuit	VA	Volt Ampere
I_C	Collector current	VAR	Reactive Power
I_E	Emitter current	W	Watt
I_f	Forward current	Wb	Weber
IM	Induction motor	Y	Admittance
J	Current density	Z	Impedance

List of Symbols

Symbol	Description	Symbol	Description
Ω	SI unit of resistance, ohm	α_{dc}	Current gain in CB configuration of a transistor
μ_o	Absolute permeability	β_{dc}	Current gain in CE configuration of a transistor
μ_r	Relative permeability	μ	Permeability of a material
C_f	Feedback capacitor	A	Temperature coefficient of resistance
R_C	Reluctance of the magnetic core	Θ	Phase angle
R_{ag}	Air gap reluctance	Λ	Flux linkage
R_f	Feedback resistor	P	Specific resistance or resistivity
f_r	Resonant frequency	Σ	Specific conductance or conductivity
K	Transformer turns ratio	Φ	Mutual flux
Ø	DC motor flux	Ω	Angular velocity

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Guidelines for Teachers

To implement Outcome Based Education (OBE) knowledge level and skill set of the students should be enhanced. Teachers should take a major responsibility for the proper implementation of OBE. Some of the responsibilities (not limited to) for the teachers in OBE system may be as follows:

- Within reasonable constraint, they should manipulate time to the best advantage of all students.
- They should assess the students only upon certain defined criterion without considering any other potential ineligibility to discriminate them.
- They should try to grow the learning abilities of the students to a certain level before they leave the institute.
- They should try to ensure that all the students are equipped with the quality knowledge as well as competence after they finish their education.
- They should always encourage the students to develop their ultimate performance capabilities.
- They should facilitate and encourage group work and team work to consolidate newer approach.
- They should follow Blooms taxonomy in every part of the assessment.

Bloom's Taxonomy

Level	Teacher should Check	Student should be able to	Possible Mode of Assessment
Creating	Students ability to create	Design or Create	Mini project
Evaluating	Students ability to Justify	Argue or Defend	Assignment
Analysing	Students ability to distinguish	Differentiate or Distinguish	Project/Lab Methodology
Applying	Students ability to use information	Operate or Demonstrate	Technical Presentation/ Demonstration
Understanding	Students ability to explain the ideas	Explain or Classify	Presentation/Seminar
Remembering	Students ability to recall (or remember)	Define or Recall	Quiz

Guidelines for Students

Students should take equal responsibility for implementing the OBE. Some of the responsibilities (not limited to) for the students in OBE system are as follows:

- Students should be well aware of each UO before the start of a unit in each and every course.
- Students should be well aware of each CO before the start of the course.
- Students should be well aware of each PO before the start of the programme.
- Students should think critically and reasonably with proper reflection and action.
- Learning of the students should be connected and integrated with practical and real life consequences.
- Students should be well aware of their competency at every level of OBE.

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