ELECTRONIC DEVICES

& CIRCUITS

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Electronic Devices and Circuits

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Brief History of Electronics

In science we study about the laws of nature and its verification and in technology, we study the applications of these laws to human needs.

Electronics is the science and technology of the passage of charged particles in a gas or vacuum or semiconductor.

Before electronic engineering came into existence, electrical engineering flourished. Electrical engineering mainly deals with motion of electrons in metals only, whereas Electronic engineering deals with motion of charged particles (electrons and holes) in metals, semiconductors and also in vacuum. Another difference is, in electrical engineering the voltages and currents are of very high-kilovolts, and Amperes, whereas in electronic engineering one deals with few volts and mA. Yet another difference is, in electrical engineering, the frequencies of operation are *50* Hertzs/60 Hertzs, whereas in electronics, it is KHzs, MHz, GHzs, (high frequency).

The beginning for Electronics.was made in 1895, when H.A. Lorentz postulated the existence of discrete charges called *electrons.* Two years later, J.J.Thomson proved the same experimentally in 1897.

In the same year, Braun built the first tube, based on the motion of electrons, and called it *Cathode ray tube* (CRT).

In 1904, Fleming invented the Vacuum diode called *'valve'.*

In 1906, a semiconductor diode was fabricated but they could not succeed, in making it work. So, semiconductor technology met with premature death and vacuum tubes flourished.

In 1906 itself. De Forest put a third electrode into Fleming's diode and he called it *Triode.* A small change in grid voltage produces large change in plate voltage in this device.

In 1912 Institute of Radio Engineering (IRE) was set up in USA to take care of the technical interests of electronic engineers. Before that, in 1884 Institute of Electrical Engineers was formed and in 1963 both institutes merged into one association called IEEE (Institute of Electrical and Electronic Engineers).

The first radio broadcasting station was built in 1920 in USA.

In 1930, black and white television transmission started in USA.

In 1950, Colour television broadcasting was started.

The electronics Industry can be divided into 4 categories :

Components	Transistors, !Cs, R, L, C components
Communications	Radio, Television, Telephone - wireless, landline communications
Control	Industrial electronics, control systems
Computation	Computers

Vacuum Tubes ruled the electronic field till the invention of transistors. The difficulty with vacuum tubes was, it generated lot of heat. The filaments get heated to > 2000° k, so that electron emission takes place. The filaments get burnt and tubes occupy large space. So in 1945, Solid State Physics group was formed to invent semiconductor devices in Bell Labs, USA.

Major milestones in development of Electronics :

1895 : H. A. Lorentz - Postulated existance of Electrons

1897 : J.J. Thomson - Proved the same

1904 : Fleming invented Vacuum Diode

1906 : De Forest developed Triode

1920 : Radio Broadcasting in USA

1930 : Black and White Television Transmission in USA.

1947: Shockley - invented the junction transistor. (BJT)

1950: Colour Television Transmission started in USA.

1959: Integrated circuit concept was announced by Kilby at an IRE convention.

1969: LSI, IC - Large Scale Integration, with more than 1000 but < 10,000 components per chip (integrated or joined together), device was announced.

1969: SSI 10 - 100 components/chip, LOGIC GATES, FFs were developed.

1970: INTEL group announced, chip with 1000 Transistors (4004m)

1971 : 4 bit Microprocessor was made by INTEL group.

1975: VLSI : Very large scale integration> 10,000 components per chip. ICs were made.

1975 : CHMOS - Complimentary High Metal Oxide Semiconductor !Cs were announced by INTEL group.

1975 : MS! (Multiplenum, Address) 100 - 1000 components/chip was developed.

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1978: LSI 8 bit microprocessors (μp), ROM, RAM 1000 - 10,000 components/chip

1980: VLSI > 1,00,000 components/chip, Ex : 16 bit and 32 bit μPs

1981: 16 bit μ p > 1,00,000 components/chip, Ex : 16 bit and 32 bit μPs

1982: 100,000 Transistors, (80286) was developed

1984: CHMOS > 2,00,000 components/chip Ex : 16 bit and 32 bit μPs

1985: 32 bit μ p > 4,50,000 components/chip Ex : 16 bit and 32 bit μPs

1986: 64 bitμ p > 10,00,000 components/chip Ex: 16 bit and 32 bit μPs

1987: MMICS Monolithic Microwave Integrated Circuits

1989: i860 Intel's 64 bit CPU developed

1990s: ULSI > 500,000 Transistors; Ultra Large Scale Integration
GS! > 1,000,000 Transistors; Giant Scale Integration

1992 : 3 million Transistors, (Pentium series)

1998: 2 Million Gates/Die

2001: 5 Million Gates/ Die

2002: 1 Gigabit Memory Chips

2003: 10 nanometer patterns, line width

2004: Commercial Super Compter 1OT. Flip Flops developed.

2010: Neuro - Computer Using Logic Structure Based on Human Brain likely
Still Nature is superior. There are 10^7 cells/cm^3 in human brain

Development ofVLSI Technology:

3 μ Technology

↓

0.5 μ Technology

↓

0. 12 μ Technology

ASICS (Application Specific Integrated Circuits)

HYBRIDICs

BI CMOS

MCMs (Multi Chip Modules)

3-D packages

Table showing predictions made in 1995 on VLSI Technology

	1995	**1998**	**2001**	**2004**	**2007**
Lithography (μ)	0.35	0.25	0.18	0.12	0.1
No. Gates/Die :	SOOK	2M	SM	10 M	20M
No. Bits/Die					
Dram	64 M	256	JG	4G	16G
Sram	16M	64 N	256 **M**	IG	4G
Wafer Dia (mm)	200	200-400	-400	-400	-400
Power (μW/Die)	15	30	40	40-120	40-200
Power Supply. V.	3.3	2.2	2.2	1.5	1.5
Frequency MHz	100	175	250	350	500

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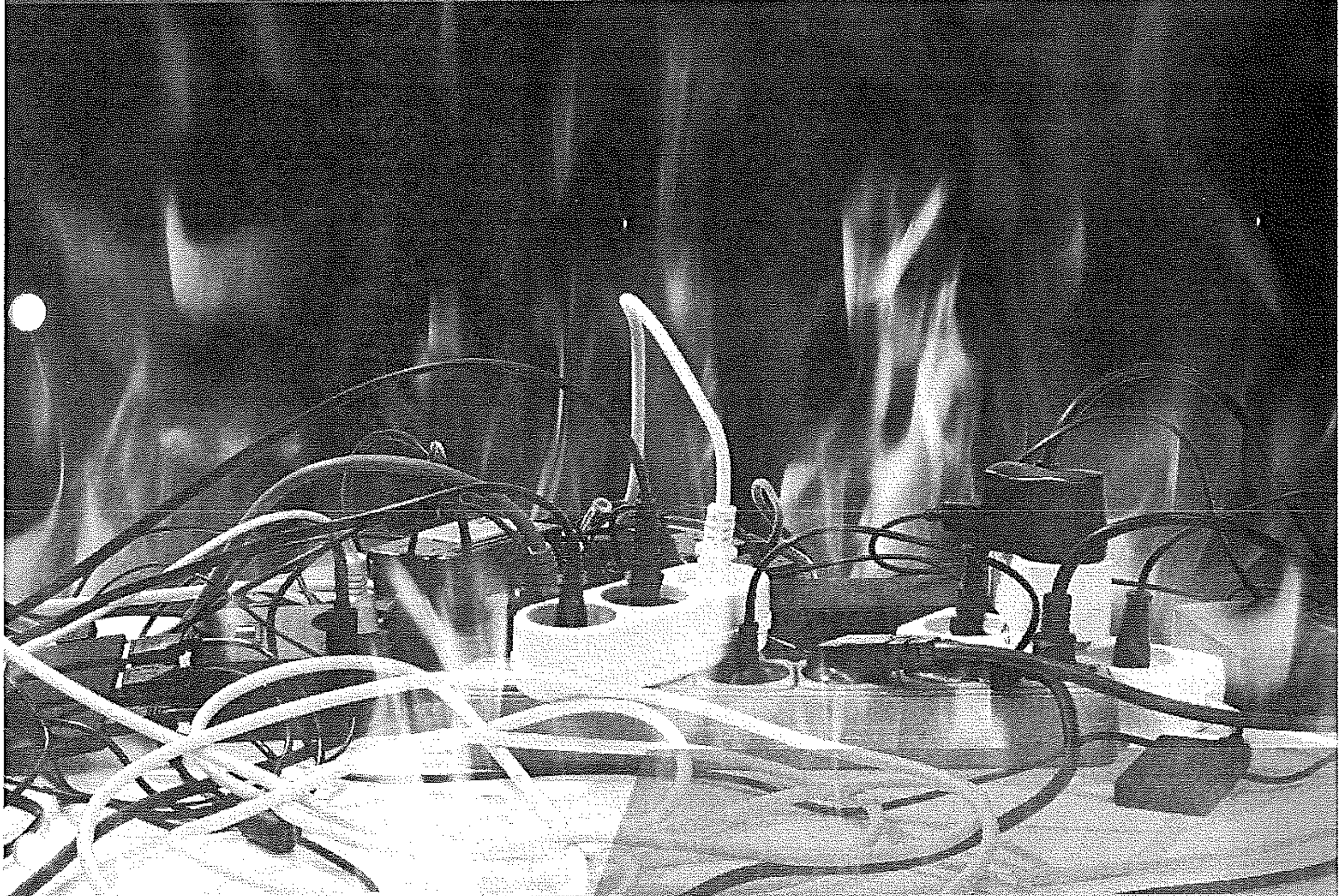

FUNDAMENTALS OF ELECTRICAL CIRCUITS

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Fundamentals of Electrical Circuits

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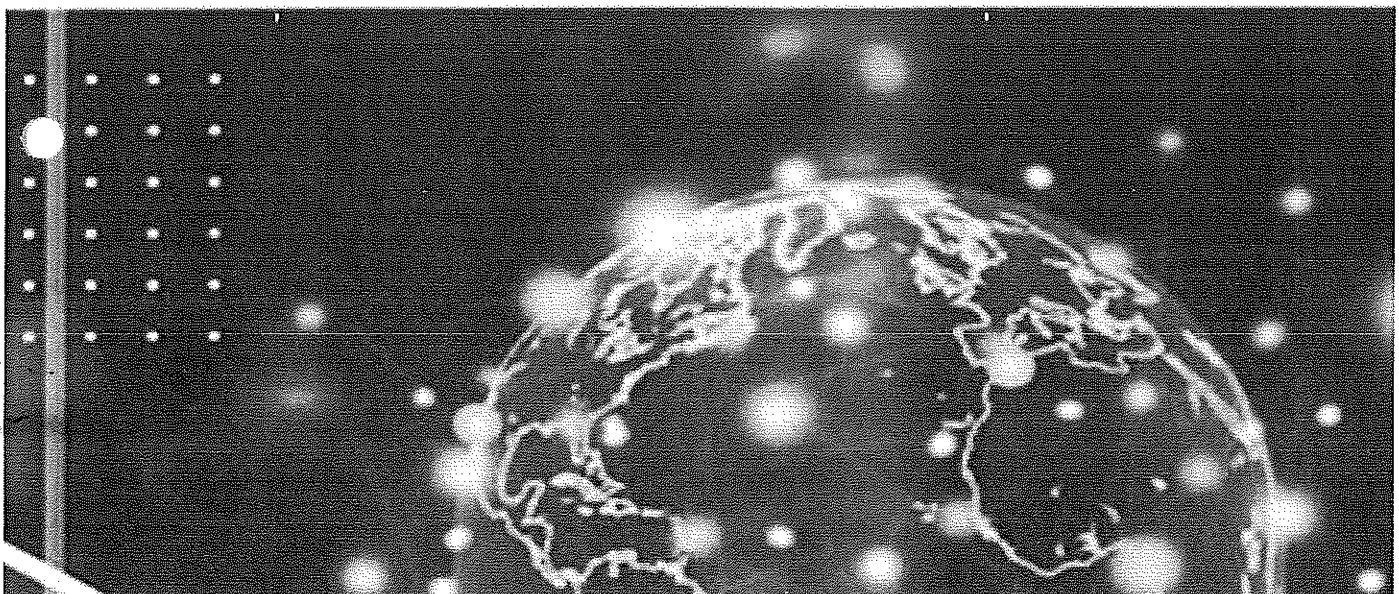
MODERN PHYSICS



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Modern Physics

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Preface

The objective of this book is to deliver an in-depth knowledge on principles of Engineering Physics to the student population to increase their general grasp on the topic. This book follows the most up-to-date curriculum of Visvesvaraya Technological University in Belgaum, Karnataka, and is intended as a textbook for first-year students in all areas of engineering. Modern physics is introduced with a focus on its foundational ideas and principles.

There are eight parts to the book. Blackbody radiation spectrum, photoelectric effect, compton effect, wave particle dualism, de- Broglie hypothesis, de- Broglie wavelength, electron particle extension, Davisson and Germer experiment, matter waves, and their characteristic properties, and an expression for de-Broglie wavelength using group velocity are all covered in the first chapter, Modern Physics. The physical importance of Heisenberg's uncertainty principle is discussed in the second chapter, "Quantum Mechanics." Particle's energy eigenvalues when it's free and when it's in an infinitely deep potential well are all results of the wave function, the time-independent Schrödinger wave equation, and their respective applications. The third chapter is dedicated to the topic of electrical conductivity in metals and covers topics such as the free-electron concept, the classical free-electron theory, the expression for drift velocity, the expression for electrical conductivity in metals, the failure of the classical free-electron theory, the quantum free- electron theory, the Fermi-Dirac statistics, the expression for electrical resistivity/conductivity, and the temperature dependence of metals' resistivity. Chapter 4 covers the dielectric constant and polarization of dielectric materials, as well as other dielectric and magnetic properties of materials. different polarization types. Internal field equation for fluids and solids, Equation of Classius and Mussoti, The electricity of Ferro and Piezo, Dielectric constant as a function of frequency, Soft and hard magnetic materials, hysteresis in ferromagnetic materials, and the classification of diamagnetic, paramagnetic, and ferro-magnetic materials.

Principle and production, Einstein's coefficients, condition for Laser action, principle, building and functioning of He-Ne and semiconductor Laser, Applications of Laser, and Holography - Principle of Recording and reconstruction of 3-D pictures are all covered in the fifth and final chapter on Lasers. Propagation mechanism in optical fibers, Optical fiber types and modes of propagation, Optical fiber applications, Temperature dependence of resistivity in superconducting materials, and so on are all covered in the sixth chapter, "Optical Fibers and Superconductivity." Superconductors and their uses, as well as the effect of a magnetic field, Type I and Type II superconductors, the BCS theory, and high-temperature superconductors. Crystal systems, Miller indices, an expression for inter-planar spacing, the atomic packing factor, and the determination of the crystal structure using Bragg's X-ray spectrometer are all covered in the seventh chapter on crystal structures. Nano-science and nano-technology, nano-material shapes, nano-material production methods, ultrasonic non-destructive testing of materials, and velocity measurements in solids and liquids are discussed in the last chapter on material science.

We worked hard to ensure that this textbook was both error-free and a valuable resource for our students. At the book's conclusion are two complete mock exams. Unit questions, objective-style questions, and assignment problems are included at the conclusion of each chapter. The authors would appreciate hearing from readers who have suggestions about how to make this book better.

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MODERN PHYSICS

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