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Physics Galaxy

Volume IIIB

Magnetism, EMI & Alternating Current

Ashish Arora

Mentor & Founder

PHYSICSGALAXY.COM

World's largest encyclopedia of online video courses on High School Students preparing for

*JEE Main * JEE Advanced * NEET * NSEP/INPhO/IPhO*



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Dedicated

to

My Parents, Son, Daughter

and

My beloved wife

In his teaching career since 1992 Ashish Arora personally mentored more than 10000 IITians and students who reached global heights in various career and profession chosen. It is his helping attitude toward students with which all his students remember him in life for his contribution in their success and keep connections with him live. Below is the list of some of the successful students in International Olympiad personally taught by him.

NAVNEET LOIWAL	<i>International GOLD Medal in IPhO-2000 at LONDON</i> , Also secured AIR-4 in IIT JEE 2000 PROUD FOR INDIA : Navneet Loiwal was the first Indian Student who won first International GOLD Medal for our country in International Physics Olympiad.
DUNGRA RAM CHOUDHARY	AIR-1 in IIT JEE 2002
HARSHIT CHOPRA	<i>National Gold Medal in INPhO-2002</i> and got AIR-2 in IIT JEE-2002
KUNTAL LOYA	A Girl Student got position AIR-8 in IIT JEE 2002
LUV KUMAR	<i>National Gold Medal in INPhO-2003</i> and got AIR-3 in IIT JEE-2003
RAJHANS SAMDANI	<i>National Gold Medal in INPhO-2003</i> and got AIR-5 in IIT JEE-2003
SHANTANU BHARDWAJ	<i>International SILVER Medal in IPhO-2002 at INDONESIA</i>
SHALEEN HARLALKA	<i>International GOLD Medal in IPhO-2003 at CHINA</i> and got AIR-46 in IIT JEE-2003
TARUN GUPTA	<i>National GOLD Medal in INPhO-2005</i>
APEKSHA KHANDELWAL	<i>National GOLD Medal in INPhO-2005</i>
ABHINAV SINHA	<i>Hon'ble Mension Award in APhO-2006 at KAZAKHSTAN</i>
RAMAN SHARMA	<i>International GOLD Medal in IPhO-2007 at IRAN</i> and got AIR-20 in IIT JEE-2007
PRATYUSH PANDEY	<i>International SILVER Medal in IPhO-2007 at IRAN</i> and got AIR-85 in IIT JEE-2007
GARVIT JUNI WAL	<i>International GOLD Medal in IPhO-2008 at VIETNAM</i> and got AIR-10 in IIT JEE-2008
ANKIT PARASHAR	<i>National GOLD Medal in INPhO-2008</i>
HEMANT NOVAL	<i>National GOLD Medal in INPhO-2008</i> and got AIR-25 in IIT JEE-2008
ABHISHEK MITRUKA	<i>National GOLD Medal in INPhO-2009</i>
SARTHAK KALANI	<i>National GOLD Medal in INPhO-2009</i>
ASTHA AGARWAL	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
RAHUL GURNANI	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
AYUSH SINGHAL	<i>International SILVER Medal in IJSO-2009 at AZERBAIJAN</i>
MEHUL KUMAR	<i>International SILVER Medal in IPhO-2010 at CROATIA</i> and got AIR-19 in IIT JEE-2010
ABHIROOP BHATNAGAR	<i>National GOLD Medal in INPhO-2010</i>
AYUSH SHARMA	<i>International Double GOLD Medal in IJSO-2010 at NIGERIA</i>
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ABHISHEK BANSAL	<i>National GOLD Medal in INPhO-2011</i>
SAMYAK DAGA	<i>National GOLD Medal in INPhO-2011</i>
SHREY GOYAL	<i>National GOLD Medal in INPhO-2012</i> and secured AIR-24 in IIT JEE 2012
RAHUL GURNANI	<i>National GOLD Medal in INPhO-2012</i>
JASPREET SINGH JHEETA	<i>National GOLD Medal in INPhO-2012</i>
DIVYANSHU MUND	<i>National GOLD Medal in INPhO-2012</i>
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PRATYUSH RAJPUT	<i>International SILVER Medal in IJSO-2012 at IRAN</i>
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DIVYANSH GARG	<i>International SILVER Medal in IPhO-2016 at SWITZERLAND</i>
NALIN KHANDELWAL	AIR-1 in NEET 2019
MRIDUL AGARWAL	AIR-1 in JEE Advanced 2021

ABOUT THE AUTHOR



The complexities of Physics have given nightmares to many, but the homegrown genius of Jaipur- Ashish Arora has helped millions of students to live their dreams by decoding it.

Newton Law of Gravitation and Faraday's Magnetic induction force apply perfectly well with this unassuming genius. A Pied Piper of students, his webportal <https://www.physicsgalaxy.com>, The world's largest encyclopedia of video lectures on high school Physics possesses strong gravitational pull and magnetic attraction for students who want to make it big in life.

Ashish Arora, gifted with rare ability to train masterminds, has mentored over 10,000 IITians and Medicos in his past over three decades of teaching sojourn including lots of students made it to Top 100 in IIT-JEE/JEE(Advance) including multiple times AIR-1 and many in Top-10. Apart from that, he has also groomed hundreds of students for cracking International Physics Olympiad. No wonder his student Navneet Loiwal brought laurel to the country by becoming the first Indian to win a Gold medal at the 2000 - International Physics Olympiad in London (UK).

His special ability to simplify the toughest of the Physics theorems and applications rates him as one among the best Physics teachers in the world. With this, Arora simply defies the logic that perfection comes with age. Even at 18 when he started teaching Physics while pursuing engineering, he was as engaging as he is now. Experience, besides graying his hair, has just widened his horizon.

Now after encountering all tribes of students - some brilliant and some not-so-intelligent - this celebrated teacher has embarked upon a noble mission to make the entire galaxy of Physics inform of his webportal PHYSICSGALAXY.COM to serve and help global students in the subject. Today students from 183 countries are connected with this webportal. On any topic of physics students can post their queries in INTERACT tab of the webportal on which many global experts with Ashish Arora reply to several queries posted online by students.

Dedicated to global students of middle and high school level, his website www.physicsgalaxy.com also has teaching sessions dubbed in American accent and subtitles in 87 languages. For students in India preparing for JEE & NEET, his online courses will be available soon on PHYSICSGALAXY.COM.

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FOREWORD

It has been pleasure for me to follow the progress Er. Ashish Arora has made in teaching and professional career. In the last about three decades he has actively contributed in developing several new techniques for teaching & learning of Physics and driven important contribution to Science domain through nurturing young students and budding scientists. Physics Galaxy is one such example of numerous efforts he has undertaken.

The third edition of Physics Galaxy provides a good coverage of various topics of Mechanics, Thermodynamics and Waves, Optics & Modern Physics and Electricity & Magnetism through dedicated volumes and many new questions included. It would be an important resource for students appearing in competitive examination for seeking admission in engineering and medical streams.

The structure of book is logical and the presentation is innovative. Importantly the book covers some of the concepts on the basis of realistic experiments and examples. The book has been written in an informal style to help students learn faster and more interactively with better diagrams and visual appeal of the content. Each chapter has variety of theoretical and numerical problems to test the knowledge acquired by students. The book also includes solution to all practice exercises with several new illustrations and problems for deeper learning.

I am sure the book will widen the horizons of knowledge in Physics and will be found very useful by the students for developing in-depth understanding of the subject.

Date : May 18, 2024

Prof. Sandeep Sancheti

Ph. D. (U.K.), B.Tech. FIETE, FIE (I), SMIEEE

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PREFACE

For a science student, Physics is the most important subject, unlike to other subjects it requires logical reasoning and high imagination of brain. Without improving the level of physics it is very difficult to achieve a goal in the present age of competitions. To score better, one does not require hard working at least in physics. It just requires a simple understanding and approach to think a physical situation. Actually physics is the surrounding of our everyday life. All the six parts of general physics-Mechanics, Heat, Sound, Light, Electromagnetism and Modern Physics are the constituents of our surroundings. If you wish to make the concepts of physics strong, you should try to understand core concepts of physics in practical approach rather than theoretical. Whenever you try to solve a physics problem, first create a hypothetical approach rather than theoretical. Whenever you try to solve a physics problem, first create a hypothetical world in your imagination about the problem and try to think psychologically, what the next step should be, the best answer would be given by your brain psychology. For making physics strong in all respects and you should try to merge and understand all the concepts with the brain psychologically.

The book PHYSICS GALAXY is designed in a totally different and friendly approach to develop the physics concepts psychologically. The book is presented in five volumes, which covers almost all the core branches of general physics. This part of book, volume 3B covers Magnetic Effects of Current, Electromagnetic Induction and Alternating Current. These are most critical topics of Physics for building strong applications of whole section of electromagnetism. The things you will learn in this book will help in building your overall strength in the branch electricity and magnetism. In this book every chapter is explained in a simple, interactive and experimental way. The book is divided in the two major chapters, first chapters is covering all the applications of magnetic effects of current and force on moving charges or current carrying conductors due to magnetic field. This chapter also includes the calculation and analysis of magnetic effects produced by different current configurations. Second chapter covers the applications on electromagnetic induction and its several applications including time varying magnetic field and concept of self and mutual induction. The chapter at the end covers the major application of induction in form of alternating current and alternating current circuits.

The best way of understanding physics is the experiments and this methodology I am using in my lectures and I found that it helps students a lot in concept visualization. In this book I have tried to translate the things as I used in lectures. After every important section there are several solved examples included with simple and interactive explanations. It might help a student in a way that the student does not require to consult any thing with the teacher. Everything is self explanatory and in simple language.

One important factor in preparation of physics I wish to highlight that most of the student after reading the theory of a concept start working out the numerical problems. This is not the efficient way of developing concepts in brain. To get the maximum benefit of the book students should read carefully the whole chapter at least three or four times with all the illustrative examples and with more stress on some illustrative examples included in the chapter. Practice exercises included after every theory section in each chapter is for the purpose of in-depth understanding of the applications of concepts covered. Illustrative examples are explaining some theoretical concept in the form of an example. After a thorough reading of the chapter students can start thinking on discussion questions and start working on numerical problems.

Exercises given at the end of each chapter are for circulation of all the concepts in mind. There are two sections, first is the discussion questions, which are theoretical and help in understanding the concepts at root level. Second section is of conceptual MCQs which helps in enhancing the theoretical thinking of students and building logical skills in the chapter. Third section of numerical MCQs helps in the developing scientific and analytical application of concepts. Fourth section of advance MCQs with one or more options correct type questions is for developing advance and comprehensive thoughts. Last section is the Unsolved Numerical Problems which includes some simple problems and some tough problems which require the building fundamentals of physics from basics to advance level problems which are useful in preparation of NSEP, INPhO or IPHO.

In this third edition of the book I have included many new questions and solutions in different exercises at practice, conceptual, numerical and advance MCQs to support students who are dependent on their self study and not getting access to teachers for their preparation.

This book has taken a shape just because of motivational inspiration by my mother in 1997 when I just thought to write something for my students. She always motivated and was on my side whenever I thought to develop some new learning methodology for my students.

I don't have words for my best friend my wife Anuja for always being together with me to complete this book in the unique style and format.

I would like to pay my gratitude to Sh. Dayashankar Prajapati in assisting me to complete the task in Design Labs of PHYSICSGALAXY.COM and presenting the book in totally new format of third edition.

At last but the most important person, my father who has devoted his valuable time in finally presenting the book in such a format and a simple language, thanks is a very small word for his dedication in building the base structure of this book.

In this third edition I have tried my best to make this book error free but owing to the nature of work, inadvertently, there is possibility of errors left untouched. I shall be grateful to the readers, if they point out me regarding errors and oblige me by giving their valuable and constructive suggestions via emails for further improvement of the book.

Date : May 18, 2024

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CONTENTS

Chapter 4

Magnetic Effects of Current & Magnetism

1-118

4.1 Biot Savart's Law	2
4.1.1 Magnetic Induction Direction by Right Hand Palm Rule	3
4.1.2 Magnetic Induction due to Moving Charges	4
4.1.3 Units used for magnetic induction	4
4.2 Magnetic Induction due to different Current Carrying Conductors Configurations	4
4.2.1 Magnetic Induction due to a Long Straight Current Carrying Conductor	5
4.2.2 Magnetic Induction due to a Finite Length Current Carrying Wire	6
4.2.3 Magnetic Induction due to a Semi-Infinite Straight Wire	6
4.2.4 Magnetic Induction at the Center of a Circular Coil	7
4.2.5 Magnetic Induction at Axial Point of a Circular Coil	8
4.2.6 Helmholtz Coils	9
4.2.7 Magnetic Induction at Center of a Circular Arc	10
4.3 Magnetic Induction due to Extended Current Configurations	17
4.3.1 Magnetic Induction Inside a Long Solenoid	17
4.3.2 Direction of Magnetic Induction Inside a Long Solenoid	18
4.3.3 Magnetic Induction due to a Semi-Infinite Solenoid	18
4.3.4 Magnetic Induction due to a finite length Solenoid	18
4.3.5 Magnetic Induction due to a Large Toroid	19
4.3.6 Magnetic Induction due to a Large Current Carrying Sheet	20
4.3.7 Magnetic Induction due to a Revolving Charge Particle	21
4.3.8 Magnetic Induction due to a Surface Charged Rotating Disc	22
4.4 Ampere's Law	24
4.4.1 Applications of Ampere's Law	25
4.4.2 Magnetic Induction due to a Long Straight Wire	25
4.4.3 Magnetic Induction due to a Long Solenoid	26
4.4.4 Magnetic Induction due to a Tightly Wound Toroid	27
4.4.5 Magnetic Induction due to a Cylindrical Wire	28
4.4.6 Magnetic Induction due to a Hollow Cylindrical Wire	29
4.4.7 Magnetic Induction due to a Large Current Carrying Sheet	30
4.4.8 Magnetic Induction due to a Large and Thick Current Carrying Sheet	30
4.4.9 Unidirectional Magnetic Field in a Region	31
4.5 Electromagnetic Interactions	36
4.5.1 Electromagnetic Force on a Moving Charge	36
4.5.2 Direction of Magnetic Force on Moving Charges	37
4.5.3 Work Done by Magnetic Force on Moving Charges	37
4.5.4 Projection of a Charge Particle in Uniform Magnetic Field in Perpendicular Direction	37
4.5.5 Projection of a Charge Particle from Outside into a Uniform Magnetic Field in Perpendicular Direction	38
4.5.6 Projection of a Charge Particle in Direction Parallel to the Magnetic Field	39
4.5.7 Projection of a Charge Particle at Some Angle to the Direction of Magnetic Field	39
4.5.8 Deflection of a Moving Charge by a Sector of Magnetic Field	40
4.6 Magnetic Force on Current Carrying Conductors	45
4.6.1 Force on a Wire in Uniform Magnetic Field	45
4.6.2 Direction of Magnetic Force on Currents in Magnetic Field	46
4.6.3 Force Between Two Parallel Current Carrying Wires	47
4.6.4 Magnetic Force on a Random Shaped Current Carrying Wire in Uniform Magnetic Field	47
4.7 Motion of a Charged Particle in Electromagnetic Field	53
4.7.1 Undelected motion of a charge particle in Electric and Magnetic Fields	53
4.7.2 Cycloidal Motion of a Charge Particle in Electromagnetic Field	53
4.8 A Closed Current Carrying Coil placed in Magnetic Field	60
4.8.1 Torque due to Magnetic Forces on a Current Carrying Loop in Magnetic Field	61

4.8.2 Interaction Energy of a Current Carrying Loop in Magnetic Field	61
4.8.3 Work Done in Changing Orientation of a Current Carrying Coil in Magnetic Field	62
4.8.4 Magnetic Flux through a surface in Magnetic Field	62
4.8.5 Stable and Unstable Equilibrium of a Current Carrying Loop in Magnetic Field	63
4.8.6 Moving Coil Galvanometer	64
4.9 Relation in Magnetic Moment and Angular Momentum of uniformly charged and uniform dense rotating bodies	69
4.10 Magnetic Pressure and Field Energy of Magnetic Field	71
4.11 Classical Magnetism	75
4.11.1 Pole Strength of a Magnetic Pole	75
4.11.2 Coulomb's Law for Magnetic Forces	76
4.11.3 Magnetic Induction in terms of Force on Poles	76
4.11.4 Magnetic Induction due to a Magnetic Pole	77
4.11.5 Bar Magnet	77
4.11.6 Magnetic Induction due to a Bar Magnet on its Axis	78
4.11.7 Magnetic Induction due to a Bar Magnet on its Equatorial Line	79
4.11.8 Analogy between Electric and Magnetic Dipoles	79
4.11.9 A Small Current Carrying Coil as a Magnetic Dipole	80
4.11.10 Force on a Magnetic Dipole in Magnetic Field	81
4.12 Terrestrial Magnetism	84
4.12.1 Direction of Earth's Magnetic Field on Surface	84
4.12.2 Some Definitions and Understanding Earth's Magnetic Field	85
4.12.3 Tangent Galvanometer	86
4.12.4 Deflection Magnetometer	87
4.12.5 Earth's Magnetic Field in Other Units	88
4.12.6 Apparent angle of dip at a point on Earth's Surface	88
DISCUSSION QUESTION	91
CONCEPTUAL MCQs SINGLE OPTION CORRECT	92
NUMERICAL MCQs SINGLE OPTION CORRECT	96
ADVANCE MCQs WITH ONE OR MORE OPTIONS CORRECT	105
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	110

Chapter 5

Electromagnetic Induction and Alternating Current

119-259

5.1 Faraday's Law of Electromagnetic Induction	120
5.1.1 Lenz's Law	121
5.1.2 Motion EMF in a Straight Conductor Moving in Uniform Magnetic Field	123
5.1.3 Motional EMF by Faraday's Law	124
5.1.4 Motional EMF as an Equivalent Battery	124
5.1.5 EMF Induced in a Rotating Conductor in Uniform Magnetic Field	125
5.1.6 EMF induced in a Conductor in Magnetic Field which is Moving in Different Directions	126
5.1.7 Motional EMF in a Random Shaped Wire Moving in Magnetic Field	126
5.1.8 EMF induced in a Rotating Coil in Uniform Magnetic Field	127
5.1.9 Motional EMF under External Force and Power Transfer	128
5.2 Time Varying Magnetic Fields (TVMF)	140
5.2.1 Charge Flown through a Coil due to Change in Magnetic Flux	140
5.2.2 Induced EMF in a Coil in Time Varying Magnetic Field	140
5.2.3 Induced Electric Field in Cylindrical Region Time Varying Magnetic Field	141
5.2.4 Induced Electric Field outside a Cylindrical Region Time Varying Magnetic Field	142
5.2.5 Electric Potential in Region of Time Varying Magnetic Field	142
5.2.6 Eddy Currents	143
5.3 Self Induction	150
5.3.1 Understanding Self Induction	151
5.3.2 Self Inductance of a Solenoid	152
5.3.3 Behaviour of an Inductor in Electrical Circuits	152

5.4 Growth of Current in an Inductor	155
5.4.1 Growth of Current in an Inductor Connected Across a Battery	155
5.4.2 Growth of Current in RL Circuit across a battery	155
5.4.3 Time Constant of RL Circuit	156
5.4.4 Instantaneous Behaviour of an Inductor	156
5.4.5 Transient Analysis of Advance RL Circuits	157
5.5 Energy Stored in an Inductor	160
5.5.1 Magnetic Field Energy Density	160
5.5.2 Field Energy Stored in a Current Carrying Inductor	161
5.6 Decay of Current in RL Circuit	162
5.7 Mutual Induction	168
5.7.1 Total Flux linked to a Coil with Mutual Induction	169
5.7.2 Relation between Coefficients of Self and Mutual Induction for a given Pair of Coils	169
5.7.3 Inductors in Series Combination	170
5.7.4 Inductors in Parallel Combination	171
5.8 LC Oscillations	174
5.8.1 Oscillation Period of LC Oscillations	175
5.9 Magnetic Properties of Matter	181
5.9.1 Magnetic Moment of Hydrogen Atom	181
5.9.2 Natural Magnetic Moment in Different Materials	181
5.9.3 Diamagnetism	182
5.9.4 Response of Diamagnetic Materials to External Magnetic Fields	182
5.9.5 Magnetic Levitation in Diamagnetic Materials	183
5.9.6 Paramagnetism	183
5.9.7 Response of Paramagnetic Materials to External Magnetic Fields	183
5.9.8 Magnetic Induction inside a Paramagnetic and Diamagnetic Materials	184
5.9.9 Intensity of Magnetization	184
5.9.10 Magnetic Field Vectors $\vec{B}$ and $\vec{H}$	185
5.9.11 Relation in $\vec{B}$, $\vec{H}$ and $\vec{I}$ in Magnetization of Materials	185
5.9.12 Magnetic Susceptibility	185
5.9.13 Curie's Law	185
5.9.14 Ferromagnetic Materials	186
5.9.15 Magnetization of Ferromagnetic Materials	186
5.9.16 Superconductor as a Perfectly Diamagnetic Material	186
5.9.17 Magnetic Hysteresis	187
5.10 Alternating Current	189
5.10.1 Mean or Average Value of an Alternating Current	190
5.10.2 Mean Value of a Sinusoidal Alternating Current	190
5.10.3 Root Mean Square (RMS) value of an Alternating Current	191
5.10.4 RMS value of a Sinusoidal Alternating Current	191
5.11 AC Circuit Components	193
5.11.1 A Resistor Across an AC EMF	193
5.11.2 A Capacitor Across an AC EMF	194
5.11.3 An Inductor Across an AC EMF	194
5.11.4 Comparison of AC Circuit Elements	195
5.11.5 Behaviour of L and C at High and Low Frequency AC	196
5.11.6 LR Series Circuit Across an AC EMF	196
5.11.7 RC Series Circuit Across an AC EMF	198
5.12 Phasor Analysis	202
5.12.1 Standard Phasors for Resistances and Reactances in AC Circuits	203
5.12.2 Phasor Algebra	203
5.12.3 Phasor Analysis of a Resistance Across an AC EMF	205
5.12.4 Phasor Analysis of a Capacitor Across an AC EMF	205
5.12.5 Phasor Analysis of an Inductor Across an AC EMF	205
5.12.6 Impedance of an AC Circuit	206

5.12.7 Phasor Analysis of Series RL Circuit Across AC EMF	207
5.12.8 Phasor Analysis of Series RC Circuit Across AC EMF	208
5.12.9 Phasor Analysis of Series LC Circuit Across AC EMF	208
5.12.10 Series RLC Circuit Across AC EMF	209
5.12.11 Phase Relations in Series RLC Circuit	209
5.13 Power in AC Circuits	213
5.13.1 Average Power in AC Circuits	213
5.13.2 Wattless Current in AC Circuits	213
5.13.3 Maximum Power in an AC Circuit	214
5.13.4 Resonance in Series RLC Circuit	214
5.13.5 Variation of Current with Frequency in Series RLC Circuit	214
5.13.6 Half Power Frequencies in Series RLC Circuit	215
5.13.7 Bandwidth for a Series RLC Circuit	215
5.13.8 Quality Factor of Series RLC Circuit	216
5.13.9 Selectivity of a Resonance Circuit	216
5.13.10 Parallel RLC Circuit	216
5.14 Transformer	220
5.14.1 Power Relations in a Transformer	221
5.14.2 Types of Transformers	221
5.14.3 Losses in Transformers	221
5.14.4 Efficiency of a Transformer	222
DISCUSSION QUESTION	225
CONCEPTUAL MCQs SINGLE OPTION CORRECT	227
NUMERICAL MCQs SINGLE OPTION CORRECT	236
ADVANCE MCQs WITH ONE OR MORE OPTIONS CORRECT	244
UNSOLVED NUMERICAL PROBLEMS FOR PREPARATION OF NSEP, INPHO & IPHO	249

ANSWERS & SOLUTIONS

Chapter 4	Magnetic Effects of Current & Magnetism	260 - 295
Chapter 5	Electromagnetic Induction and Alternating Current	296 - 336

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