Electrodynamics: The Field Free Approach
Demonstration Movies of Relevant Phenomena
Chapters 2 - 11

2.1 Electric charges at rest – Electric force

Creating net charge by friction
http://www.youtube.com/watch?v=nCm2UCj6eDU - Lightning
http://www.youtube.com/watch?v=rtl9TyMZSP8 - Friction
https://www.youtube.com/watch?v=Sqhgrw3bDmU - Electrophourus
http://www.youtube.com/watch?v=aeiqw81kGio - Charged rod and small ball

Variuos electrostatic demonstrations
http://www.youtube.com/watch?v=yU55lXbrV0U - Electrostatic experiments
Enjoy this movie on electric forces, maybe the best physics lecture ever
https://www.youtube.com/watch?v=kFAp417tZbU - Lecture

Coulomb force law, formula (2.1)
https://www.youtube.com/watch?v=N46RKNbKf2s - Finding Coulomb force law
https://www.youtube.com/watch?v=zjTzO4mQlEs - Electric force on air flow table

Free electron interacting with charged plate
http://www.youtube.com/watch?v=PpOAlj7sOEc - Electron tube and charged parallel plates

2.2 Electric charges in uniform motion – Magnetic force

The interaction between parallel and antiparallel currents: fig. (2.3) and (2.4), formula (2.3)
http://www.youtube.com/watch?v=43AeuDvWc0k - Magnetic force, two parallel wires 1
https://www.youtube.com/watch?v=JmBSEJQiapA - Magnetic force, two parallel wires 2
http://www.youtube.com/watch?v=ubOTTPD1GL0 - Magnetic force, many parallel wires

The interaction between perpendicular currents: fig. (2.5) and formula (2.4)
http://www.youtube.com/watch?v=o1z2S3ME0cI - Free electrons and parallel coils 1

2.3 Electric charges in accelerated motion – Inductive force

Alternating current induces current, formula (2.20). Note dependence on distance and relative orientation.
http://www.youtube.com/watch?v=gfUuwnD2-fg - AC in one coil induces AC in another 1
https://www.youtube.com/watch?v=Rr8AFw1HC1k - AC in one coil induces AC in another 2

3 Magnetic energy

Exploring mutual inductance, formula (3.30).
https://www.youtube.com/watch?v=RMO3RylUbT8 - Mutual inductance between two coils

4 Macroscopic systems

This movie investigates how the voltage between two charged plates and their charge vary with distance between plates, formula (4.23):
http://www.youtube.com/watch?v=e0n6xLdwaT0 - Parallel charged plates

The force between two parallel current coils, exc. (4.16):
http://www.youtube.com/watch?v=hE2Ksi-MLH0 - Magnetic force, two loops 1
http://www.youtube.com/watch?v=zYIVCskpxdI - Magnetic force, two loops 2

In section (4.2.6), a conductor in motion beside a current-carrying plane (a magnet) was considered. A similar phenomenon is demonstrated in this movie. The conductor is a rotating disc.
This is also a demonstration of geomagnetism, exc. (7.18), where the disc corresponds to earth and the magnet to the influence from the sun.
https://www.youtube.com/watch?v=X54gibrRgIA - Conductor moving relative magnet

Same phenomenon as above, but now the magnet may also be in motion:
https://www.youtube.com/watch?v=gduYoT9sMaE - Faraday disc plus paradox

5 Conductors and resistive effects

A metal shield protects us from lightning, section (5.2):
http://www.youtube.com/watch?v=WqvImbn9GG4 - Faraday's cage

Resistance decreases with temperature, section (5.11)
https://www.youtube.com/watch?v=XxBn_Wzm0aI - Conduction is temperature dependent

The interaction between a current coil and a free electron beam, exc. (5.12):
http://www.youtube.com/watch?v=zwZEBsefIzM - Free electrons

The Millikan apparatus for determining electron charge, exc. (5.13). These movies records what is seen by the observer. Note the reversed motion of the drop and their constant speed.
https://www.youtube.com/watch?v=3_0w1YEOwRY - Millikan oil drop 1
https://www.youtube.com/watch?v=xwNQSMdoxoA - Millikan oil drop 2

Heat generated by electric current, section (5.4).
https://www.youtube.com/watch?v=mNri-cH-GgA - Joule effect

6 Electric Circuits

Here are two demonstrations of forced LC resonance, formula (6.25), section (6.3.2). The first one varies inductance by introducing iron in a coil, see section (8.2), formula (8.38).
https://www.youtube.com/watch?v=ZYgFuUl9_Vs - LC resonance

https://www.youtube.com/watch?v=V6J2rwEqy5I - LC series circuit resonance

Using RC and RL circuit with input square wave, C and L are determined through rise time: section (6.1) and (6.2), formulas (6.4) and (6.7).
https://www.youtube.com/watch?v=74fz9iwZ_sM - LC circuit

7 Electric and Magnetic Dipoles

This is an example of an interaction between a charge and a dipole, section (7.1.1)
https://www.youtube.com/watch?v=jkYz1WlpRSQ - Water attracts charged balloon

The interaction between a current loop and a magnet forms a motor. Compare exc. (7.9)
https://www.youtube.com/watch?v=WKklyuzghQg - Electromagnetic motor

Magnetic dipole-dipole interaction, section 7.2, formula (7.25)
https://www.youtube.com/watch?v=3xM06CRcGkU - Permanent magnetic ball and current loop

Modelling geomagnetism. The disc corresponds to earth and the magnet to the influence from the sun, exc. (7.18). See also Ch 4 on this sheet.
https://www.youtube.com/watch?v=X54gibrRgIA - Conductor moving relative magnet

A long movie of geomagnetism, exc. (7.18).
https://www.youtube.com/watch?v=NJUTUFAWfEY - Geomagnetism

8 Material Properties

8.1 Electric response forces

Inserting a non-conducive material between the plates of a charged capacitor, section (8.1), fig. (8.2). With field theoretical explanation (Ch 10).
https://www.youtube.com/watch?v=PF0g4EcBVh0 - Dielectric in capacitor

A non-conductive slab interacts with parallel charged plates, section (8.1.1)
https://www.youtube.com/watch?v=aBAdSE2jC8Y - Dielectric slab

Electric pulses from an electric fish, exc. (8.20)
https://www.youtube.com/watch?v=ubnCo1N0EeQ - Electric fish

Electrically charged object induces dipoles of a neutral material and an attractive interaction occurs
https://www.youtube.com/watch?v=AC4PAfIEwBs - Induced electric dipoles

A liquid is drawn into a charged capacitor, section (8.4.2), fig. (8.19)
https://www.youtube.com/watch?v=muXqn76eX0I - Dielectric constant measurement
https://www.youtube.com/watch?v=ACDxurDAmyg - Long version

8.2 Magnetic response forces

Varying inductance by introducing iron in a coil, section (8.2), formula (8.38).
https://www.youtube.com/watch?v=ZYgFuUl9_Vs - LC resonance

Strong neodymium magnet acts on a grape. A diamagnetic effect appears due to the water of the grape. Compare section (8.2.2.1).
You may repeat this experiment with a dry grape.
https://www.youtube.com/watch?v=zO06OSgcP-I - Grape and Nd magnet

Demonstrating the diamagnetic property of water. Compare last part of section (8.4.2).
https://www.youtube.com/watch?v=jyqOTJOJSoU - Water diamagnetism

A direct demonstration of the diamagnetic property of water
https://www.youtube.com/watch?v=DpQvEfoMajk - Diamagnetism of water

Electric and magnetic property of water in the same demonstration
https://www.youtube.com/watch?v=7b-w0oWttN0 - Water magic

Measure magnetic susceptibility with the method described in section (8.4.2)
https://www.youtube.com/watch?v=EOk9sirEndE - Magnetic susceptibility measurement

Demonstration of conductor moving close to magnet. The magnet is two current coils. Eddy currents are generated. Compare exc. (8.11e).
https://www.youtube.com/watch?v=7_-RqkYatWI - Eddy currents

Magnet falls inside aluminium, copper and glass tubes, demonstrating Lenz´law, exc. (3.5) and (8.11e)
https://www.youtube.com/watch?v=sPLawCXvKmg - Ordinary magnet
https://www.youtube.com/watch?v=E97CYWlALEs - Neodynium magnet

A specific material becomes superconducting when cooled with liquid nitrogen. When interacting with a permanent magnet it opposes external forces (gravity in these cases), exc. (8.11).
https://www.youtube.com/watch?v=pPBsxylW2Z0 - Superconduction
Note the attractive effect in this case when a superconductive material moves on a track of magnets:
https://www.youtube.com/watch?v=zPqEEZa2Gis - Superconduction

9 Motional consequences

Three movies about time dilation, section (9.4.2).

Muon decay experiment, exc. (9.4)
https://www.youtube.com/watch?v=ejcaz7wXawY - Time dilation muon decay

Relativistic time influences GPS technonlogy
https://www.youtube.com/watch?v=zQdIjwoi-u4 - Motional and gravitational relative time

Aircraft experiment on relative time
https://www.youtube.com/watch?v=cDvmN_Pw96A - Gravitational relative time

10 Field theory

High voltage induces electric dipoles in semolina seeds. The dipoles align with the hypothetic electric field lines, section (10.3).
https://www.youtube.com/watch?v=t8InVvftLHY - Semolina as electric dipoles
https://www.youtube.com/watch?v=7vnmL853784 - Semolina as electric dipoles

A current induces magnetic dipoles in iron filings. The dipoles align with the hypothetic magnetic field lines, section (10.3).
https://www.youtube.com/watch?v=V-M07N4a6-Y - Iron filings as magnetic dipoles
Compare with a permanent magnet to demonstrate the equivalence between the magnet and a current coil, fig. (7.7):
https://www.youtube.com/watch?v=8llkHQtaOlg - Iron filings as magnetic dipoles

Basic electrodynamic phenomena with field theoretical description
https://www.youtube.com/watch?v=l-RjuauyuzM - Field theory

11 Antenna theory

Straight wire as a transmitting and receiving antenna, section (11.2)
https://www.youtube.com/watch?v=4xF1Fq2wB1I - Dipole antenna

History of electromagnetic waves and antennas. Hertz' experiment discovered the electromagnetic wave propagation, section (11.5)
https://www.youtube.com/watch?v=JzHQY8YImgs - Hertz' experiment and more
https://www.youtube.com/watch?v=xNTHbiKmwNQ - Hertz' experiment. Short

Using the phenomenon of Brewster reflection to determine refractive index, exc. (11.6).
https://www.youtube.com/watch?v=ZlvAfXaG97E - Brewster reflection
https://www.youtube.com/watch?v=Q-gdt1Caruw - Brewster reflection

http://www.springer.com/978-3-319-13170-2

Electrodynamics: The Field-Free Approach
Electrostatics, Magnetism, Induction, Relativity and Field Theory
Prytz, K.
2015, XXV, 361 p. 204 illus., 4 illus. in color., Hardcover
ISBN: 978-3-319-13170-2