SMART’10
Sponsored by
the National Science Foundation

Polytechnic Institute of New York University
Mechanical Engineering
Project URL: mechatronics.poly.edu/smart/
ORIENTATION
Project Director

- Professor Vikram Kapila
- Associate Professor
- Room: RH 504
- Phone: (718) 260-3161
- E-mail: vkapila@poly.edu
- URL: mechatronics.poly.edu/vkapila/
Laboratory Etiquette

• E-mail checking, chatting, web browsing, listening to music, singing, and running around not permitted in the lab

• Do not touch experiments unrelated to your work

• No Food and drink

• Keep this room as clean as the work allows
  – after experiments, put all components in their original place with the same original condition

• Sign on the attendance sheet
Laboratory Safety Guidelines

• Do not work alone or unsupervised
• Do not operate any equipment with indication of damage
• Do not let wires hang loose
• Do not touch unshielded wires
• Do not subject components to power higher than their ratings
• Do not touch components subjected to excessive power
• In the case of safety hazards or serious injury:
  – Warn others
  – Inform instructor or technician
  – Remove yourself from danger
# Schedule

<table>
<thead>
<tr>
<th>Start Date</th>
<th>July 5, 2010 (Monday)</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Date</td>
<td>August 13, 2010 (Friday)</td>
</tr>
<tr>
<td>Period</td>
<td>6 weeks (Monday–Friday)</td>
</tr>
<tr>
<td>Time</td>
<td>8:30am–5pm</td>
</tr>
<tr>
<td>Lunch Time</td>
<td>12:30pm–1:30pm</td>
</tr>
<tr>
<td>Location</td>
<td>RH500 / RH514B</td>
</tr>
<tr>
<td>Week</td>
<td>Mon</td>
</tr>
<tr>
<td>-------</td>
<td>------</td>
</tr>
<tr>
<td>1st</td>
<td>July 5</td>
</tr>
<tr>
<td>1st</td>
<td>Registration &amp; opening</td>
</tr>
<tr>
<td>1st</td>
<td>Orientation, surveys, and quizzes</td>
</tr>
<tr>
<td>2nd</td>
<td>12</td>
</tr>
<tr>
<td>2nd</td>
<td>Lecture, lab, and discussion</td>
</tr>
<tr>
<td>2nd</td>
<td></td>
</tr>
<tr>
<td>3rd</td>
<td>19</td>
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<tr>
<td>3rd</td>
<td>Research activities</td>
</tr>
<tr>
<td>4th</td>
<td>26</td>
</tr>
<tr>
<td>4th</td>
<td>Research activities</td>
</tr>
<tr>
<td>5th</td>
<td>August 2</td>
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<tr>
<td>5th</td>
<td>Research activities, report preparation, and presentation slides</td>
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<tr>
<td>6th</td>
<td>9</td>
</tr>
<tr>
<td>6th</td>
<td>Research activities, report preparation, and presentation slides</td>
</tr>
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</table>
# Lecture Schedule

<table>
<thead>
<tr>
<th>Lecture</th>
<th>Topics</th>
<th>Lecture</th>
<th>Topics</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Resistor</td>
<td>10</td>
<td>Thermal sensors</td>
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<tr>
<td>2</td>
<td>Mechatronics</td>
<td>11</td>
<td>Robotics</td>
</tr>
<tr>
<td>3</td>
<td>LED</td>
<td>12</td>
<td>Infrared sensor</td>
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<tr>
<td>4</td>
<td>Button</td>
<td>13</td>
<td>Transistor</td>
</tr>
<tr>
<td>5</td>
<td>Capacitor</td>
<td>14</td>
<td>Relay</td>
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<tr>
<td>6</td>
<td>Optoelectronics</td>
<td>15</td>
<td>H-Bridge</td>
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<tr>
<td>7</td>
<td>ADC</td>
<td>16</td>
<td>DC motor</td>
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<tr>
<td>8</td>
<td>Servomotor</td>
<td>17</td>
<td>RC filter</td>
</tr>
<tr>
<td>9</td>
<td>555 timer</td>
<td>18</td>
<td>Op amp</td>
</tr>
</tbody>
</table>
Making Groups

• Make 5/6 groups
• All structured projects and research activities will be done in the same teams
Ice Break

• Name
• School
• Specialty
• Hobby
• Goal for the SMART program
• Others
SMART 2003 Projects
Static Equilibrium

Teachers: Robert Gandolfo & Paul Friedman
The Smart Road

Teachers: Clay Davis & Richard Balsamel
Catch Me If You Can

Teachers: John Luvera & Michael McDonnell
The Physics of Projectile Motion

Teachers: William Leacock & Marlene McGarrity
The Ro-Boe-Clock

Teachers: Michelle Carpenter-Smith & David Deutsch
Reflection Experiment
Refraction Experiment
Static Friction Experiment
Pendulum Experiment
Heat Conduction Experiment
SMART 2004 Projects
The SMART Weather Balloon

Teachers: Ronald Occhiogrosso & Lennox Henry
Quantum Leap

Teachers: Amanda, Gunning, & Ram Avni
Velocity Monitoring via Magnetic Interaction

Teachers: Vincent Pereira & Steven Scharf
The SMART Intersection

Teachers: Michael Koumoulllos & Robert Winston
I Push! You Push Back!: Newton’s 3rd Law in Action

Teachers: Dvora Geller, Ed Gruber, & Denise McNamara
Conductivity Experiment
SMART 2005 Projects
Coefficient of Restitution
the Bouncing Ball

Teachers: Lennon Safe and Carol Obler
Vehicle of Revolution

Teachers: Henry Penna, Michael Fishenfeld, and Douraine Stewart
Earth’s Seasonal Heat Absorption and Climate Regions Model

Teachers: Joseph Renna and Rodolfo Vera
The Heat Seeking Flame Probe

Teachers: Michael Francesco and Fady Ishak
Finding the Critical Angle of a Prism

Teachers: Mustafa Kilic and Thomas Byrne
The Smart Resonance Tube

Teachers: Joe Rodichok and Robert Morris
The Codon Decoder

Teachers: Vera Mihalcik and Cameron Jahn
Robo Submarine

Teachers: Joy Hinds and James Kevin McMahon
SMART 2009 Research Projects
Temperature Control Instrument for Creep Test

Teachers: Toufik Ayoub and Leila Cohen
iPhone Controlled Robot

Teachers: Lindrick Outerbridge
Crack Detection in Beams using Chaotic Excitation

Teachers: Seth Akomah
Laser Doppler Velocimetry Traverse System

Teachers: Henry Penna and Mirlene Leveille
Biomimetic Sound-Localization

Teachers: Jason Farina
Fiber-Optic Loop Sensor

Teachers: John Schineller and Robert Gandolfo
Sample Mechatronics Projects
Remote Robot Arm Manipulation
Remote Emergency Notification System
Smart Irrigation System
RoboDry
Smart Cane
Four-Legged Hexapod
Robotic Vacuum Cleaner
Remote Control using the Parallel Port of a PC
Audio Enabled Emergency Hexapod
Automated Distinguisher
Local Navigation System
The Safe 'N Sound Driver
Type X
The Smart Walker
Autonomous Polyurethane Applier
## SMART Teachers’ Accomplishments

| Grants | | | | | |
|---|---|---|---|---|
| Richard Balsamel | Science High School | Newark, NJ | $4,000 | School district | Mechatronics research club |
| David Deutsch | Manhattan Center for Science and Math High School | New York, NY | $3,000 | School and through the Children’s Aid Society | After-school mechatronics club |
| Paul Friedman | Seward Park High School | New York, NY | $1,500 | School’s alumni association | After-school program |
| William Leacock | W. C. Mepham High School | Bellmore, NY | $1,500 | School district | Hands-on activity in AP Physics class |
| Marlene McGarrity | The Christa McAuliffe School | Brooklyn, NY | $1,500 | Online grant agency | 7th Grade class |
| Michael McDonnell | Midwood High School | Brooklyn, NY | $300,000 | VATEA | Robotics curriculum |
| Denise McNamara | High School for Health Professions and Human Services | New York, NY | $1,600 | School | Obtaining LEGO Robotics and Parallax Kits |

| Articles | | | | |
|---|---|---|---|
| Robert Gandolfo | Plainedge High School | Massapequa, NY | SMART experience in his school district newspaper |
| William Leacock | W. C. Mepham High School | Bellmore, NY | Article, “A SMART Program for Teachers,” on TechLearning |
Some New York City teachers are hoping to bring all sorts of high-tech concepts into their classrooms next school year to inspire more students to pursue careers in engineering and electronics. As NY1 Tech Beat reporter Adam Balkin explains in the following story, students won't just be hearing about those concepts, they'll be building them too.

Classrooms have certainly come a long way since the abacus and the quill. How far? Polytechnic University in Brooklyn is running a new program this summer, educating area high school teachers on how to bring mechatronics into the classroom. It's a program funded by the National Science Foundation called SMART.

"SMART stands for 'science and mechatronics aided research for teachers,'" says Vikram Kapila of Polytechnic University. "Mechatronics is marriage of mechanical engineering, electrical engineering, electronics, computer science and computer engineering to make smart products."

These projects aren't just designed to look neat or be like high-tech erector sets - they're built to actually do something eventually in the real world. A hexapod, for example, could be used for disaster recovery. After a building collapse it could be sent in to look for possible survivors.

"These could be robots, smart jet engines, automotive hybrid systems, rockets, missiles, or what have you," says Kapila.

"This is like a simulator for a jet pilot, and what they'd do before they actually become jet pilots, but most of it has to do with the fact that I'm controlling the helicopter basically by using sensors," says Clay Davis of Manhattan Comprehensive Day/Night High School.

The teachers all agree, students are more eager to learn when they can use concepts and equations to actually make something they can touch and use.

"It's tangible," says Paul Friedman of Seward Park High School. "You look at a differential equation and it's a differential equation. It just sits there, and this is real. It's live, and it has applications."

Michelle Carpenter-Smith of Packer Collegiate Institute says, "I think this is a way for me to bring projects back that will interest females as well as male students so that hopefully more female students will go into engineering, go into math and science professions, and they'll bring their way of viewing engineering from a creative perspective, from an artistic perspective, so that there can be more representation from both genders."

The program runs for four-weeks. After it's over, each teacher is given supplies to build some of these projects back at their high schools. For more information on the program, including a list of which high schools are participating, visit mechatronics.poly.edu/smart.

- Adam Balkin
Teachers go hi-tech

Taking Poly U science know-how back to HS
People: PI, graduate students, and undergraduates partnered with 21 New York city metropolitan area pre-college STEM educators for 4 weeks in 2003 (10 teachers), 2004 (11 teachers), and 2005 (17 teachers) summer to develop projects demonstrating concepts of projectile motion, speed, time, static balance, mobile robotics, etc.
“Smart” Teachers

Mr. Richard Balsam of Science High School, Newark, NJ, raised over US$4,000 from his school district for mechatronics kits and supplies and began a mechatronics research club. In addition, he is introducing mechatronics in his physics classes by integrating four sample activities for students. Mr. David Deutsch of Manhattan Center for Science and Math High School, New York, NY, has raised over US$3,000 from his school and the Children’s Aid Society for mechatronics and robotics kits. He is training students in an after-school mechatronics club. Mr. Paul Fried- man of Seward Park High School, New York, NY, has raised over US$1,500 from his school’s alumni association for robotics kits. He has partnered with a colleague to train students in an after-school program. Mr. Robert Gandolfo of Plainedge High School, North Massapequa, NY, reported on his SMART experience in his school district newspaper [12]. Mr. William Leacock of W.C. Mepham High School, Bellmore, NY, received a US$1,500 minigrant from his school district for mechatronics kits. Every other day, during a single class period of AP physics, he teaches a short lesson introducing his students to a hands-on activity planned for a double class period the following day. Mr. Leacock wrote the following to us: “The students are enjoying it so much that, even though I allow them a break in between the double periods, almost all of them stay and work right through the break. It is wonderful to see them learn and enjoy themselves so much.” Mr. Michael McDonnell of Midwood High School, Brooklyn, NY, used over US$5,000 funding from his school to obtain robotics kits and taught robotics to over 200 students in the Fall of 2003 and Spring of 2004 through robotics and advanced robotics courses. Furthermore, with colleagues, he applied for and received a three-year US$300,000 grant from his school district under the Vocational and Technical Education Act (VATEA). The VATEA grant will enable him to develop and implement a four-year robotics curriculum in his school. Finally, Ms. Marlene McGarrity of the Christa McAuliffe School, Brooklyn, NY, raised over US$1,500 for a project titled “Young Engineers are Made in Brooklyn Through Robotics and Mechatronics,” through an online grant agency. From this grant, she obtained wheeled robots and Mars rover kits, and is using these in her seventh-grade classroom. She also wrote an article [13] on her SMART experience.
Matlab Data Acquisition and Control Toolbox for Basic Stamp Microcontrollers

Anshuman Panda, Hong Wong, Vikram Kapila, and Sang-Hoon Lee
Matlab-Based Graphical User Interface Development for Basic Stamp 2 Microcontroller Projects

Simulink block diagram used for PC to BS2 serial communication

Unfiltered and Filtered plot of rctime

DB-9 serial cable

Pentium class PC

BS2 installed on BOE development platform

Simulink block diagram used for bi-directional serial communication between BS2 and PC

Plot of rctime vs. angle of light sensor

Yang-Fang Li, Saul Harari, Hong Wong, and Vikram Kapila

NYU:poly

SMART 2010

NEW YORK UNIVERSITY
Internet-Based Remote Control using a Microcontroller and an Embedded Ethernet Board

Internet

Web Client

Embedded Ethernet Board (EEB)

BS2P40 Microcontroller

ADC

DAC

Potentiometer Signal

Power Electronics

DC Motor

Ethernet Enabled BS2P40

DC motor test-bed

Java applet GUI screen capture

Imran Ahmed, Hong Wong, and Vikram Kapila

SMART 2010
Matlab-Based Graphical User Interface Development for PIC Microcontroller Projects

Simulink block diagram used for PIC to PC serial communication

Pentium class PC

DB-9 serial cable

PIC development board

Unfiltered and Filtered plot of ADC

Simulink block diagram used for bi-directional serial communication between PIC and PC

Plot of angle of refraction vs. light sensor output

Sang-Hoon Lee, Yang-Fang Li, and Vikram Kapila
Internet-Based Remote Control of a DC Motor using an Embedded Ethernet Microcontroller

Hong Wong and Vikram Kapila
MPCRL Demonstration

• Web-enabled Mechatronics/Process Control Remote Laboratory (MPCRL)

• URL: http://mechatronics.poly.edu